Power and The Engineer

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TIME has proven that the pioneers in steam-engine design, Sickels and Corliss, had the right idea when they designed the releasing valve gear. Although nearly seventy years have elapsed since the first of these gears was put into use, the germ of the invention, more or less disguised to meet the requirements of modern practice, is to be found in practical operation in thousands of engine rooms at the present time.

Because of the fact that Corliss did more to perfect this type of gear than any other man, his name is usually associated with it, and engines so equipped are commonly known as Corliss engines.

All Corliss gears have two essential features: First, four separate ports to which steam is distributed; namely, two admission and two exhaust ports. Second, an external mechanism by which the rotary valves are operated quickly and positively at the various points of the steam cycle, the governor controlling the point of cutoff at which the valve is released by a spring or dashpot.

As there are separate ports for admission and exhaust, the former can be made narrow, which, with the quick opening and closing of the admission valve, insures full steam pressure right up to the point of cutoff and prevents wire-drawing the steam. Also the rapid opening and closing of the exhaust ports produces an almost constant back pressure. These features make it possible to obtain an indicator diagram resembling very closely the theoretical diagram.

The valves are independent of one another and are easily adjusted for any desired distribution of steam. This, with a variation in cutoff by the governor to suit the load, insures an economical consumption of steam. For these and many other reasons the Corliss engine is unequaled for certain kinds of service.

The distinguishing feature between the valve gears of the various makes of Corliss engine lies in the external mechanism between the governor and the valve stem. Some of these are examples of very ingenious kinematic systems, while others are of very simple design.

Every engineer should be familiar with the numerous makes of Corliss valve gear; not because of the fact that he may be called upon at any time to operate any one of them, for the engineer who knows his business could easily solve their method of working after a few minutes' study, but a familiarity with the various types enables him to make a more intelligent selection when choosing an engine to meet certain requirements.

This issue contains the first instalment of an article upon the "Development of Releasing Valve Gears," which is unusually complete in its treatment of the subject. The article covers the development of the releasing gear from the rather crude forms of its earliest application to the highly-perfected gears on the market at the present time. Each gear is illustrated, its distinctive features are pointed out, and its operation explained; special care has been taken to make the illustrations uniform so that the sketches may be readily compared.

Aside from its historical value the subject of releasing valve gears is a live topic which no engineer can afford to pass by.

Training Engineers at Franklin Union

By F. L. Johnson

This institution, which owes its establishment to Benjamin Franklin, is an industrial school for men who desire an advanced knowledge and a wider experience in their vocations. Though covering a wide field in industrial pursuits it furnishes exceptional opportunities to the engineer.

In 1791, Benjamin Franklin bequeathed to his native town of Boston the sum of $5000, to be held in trust for one hundred years, during which time the principal and its accruing interest were to be lent at 5 per cent. per year for the purpose of aiding "married artificers starting in business."

At the end of the first century the fund was to be divided: A portion to be spent in such "public works which may be judged of most general utility to the inhabitants, such as fortifications, bridges, aqueducts, public buildings, pavements or whatever may make life in the town more convenient to its people and render it more agreeable to strangers resorting thither for health or a temporary residence."

In 1891 the first portion of the fund became available for the purpose intended. But owing to several reasons, among which were litigation and an attempt of the city government to spend a large portion of it in a junketing expedition to find out how to invest the rest of it, it was not used at that time.

It was finally decided that the Supreme Court of Massachusetts should be asked to construe the meaning of the terms of the bequest; this resulted in the appointment by the court of a board of twelve managers of whom but one, the mayor, could possibly be a public official or politician.

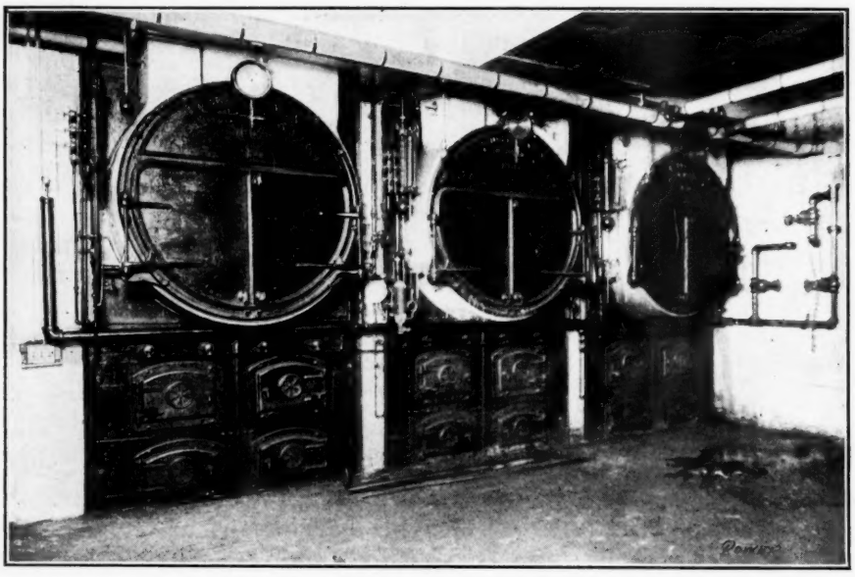


FIG. 1. FRONT VIEW OF BOILERS

The men selected for the board of managers were Richard Olney, president; Nathan Matthews, vice-president; James J. Storrow, secretary; William Endicott, treasurer; Rev. Charles W. Duane, Frank K. Foster, Charles T. Gallagher, Mayor George A. Hibbard, Rev. Alexander K. MacLennan, Rev. Charles E. Park, John A. Sullivan, Prof. George F. Swain. In the judgment of this board an industrial school was deemed the one public work of the "most general utility to the inhabitants of Boston," and some $400,000 of the fund was expended in building and equipping the Franklin Union.

As practically all of the available fund was spent in buying the land, erecting the building and supplying its equipment, nothing remained for the support of the institution. Andrew Carnegie, learning of the situation, gave a fund which provides for an annual income of $20,000 which, with the nominal sums received for tuition, furnishes the entire revenue of the institution. This, though inadequate, permits about one-half of the building to be utilized for the purposes intended.

In its equipment for practical teaching the institution is radically different from the ordinary manual-training school. Instead of competing with existing schools of a kindred nature, it supplements their work.

The foremost idea from the beginning has been the teaching of men. In the selection of the entire equipment this object has been kept in view. It aims to reach men having more or less limited experience and knowledge of their vocations with a view to increasing their experience and perfecting their knowledge.

The instruction is less of a technical nature than that given at some older and larger institutions, and is more practical than can be obtained at the evening classes of the public schools, the Young Men's Christian Association classes or the regular trade schools. As the best methods of teaching trade practice and theory are to be found in the commercial shops and enterprises, the methods of the Franklin Union have been shaped to closly follow present-day shop practice.

Instructors, so far as is possible, are selected from the shop, the engine room, the commercial laboratory and from the building trades and professions. Shop language and shop problems afford the student, with his practice instruction in shop work, the most practical way for advancement.

Though the course of instruction covers a broad field embracing several trades, there is but little that is not either directly or indirectly related to the engineer and his work; and there are probably few who would not be benefited by a course at the institution.

The character of the instruction being practical a student who is qualified may have additional work as an equivalent for that in which he is already proficient. The arrangement of the courses is the result of the most careful planning on the part of the instructors, who have not hesitated to take advantage of many valuable suggestions made by the students, making the studies of the highest value to the man from the shop or power plant.

Evening classes are held on Monday, Wednesday and Thursday evenings, from the last of September to the last of March. Two-year courses are given in the following subjects: Machine construction, industrial electricity, steam engines and boilers, structures, architectural working drawing, industrial chemistry.

Classes, without certificates, continuing for one season: Sheet-metal drafting, mechanical drawing, industrial arithmetic and shop formulas, estimating for architects and builders, firemen's class, heating and ventilating, practical mechanics, heat and hydraulics, gas and gasolene engines, ship and yacht drafting.

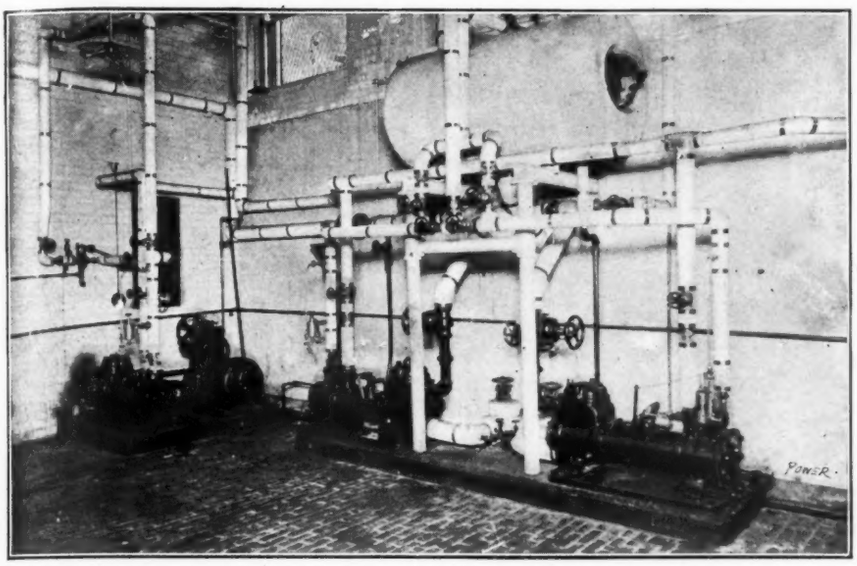


FIG. 2. FEED AND CIRCULATING PUMPS IN BOILER ROOM

Saturday afternoon classes are held in industrial chemistry, steam engines and boilers, industrial electricity, gas and gasolene engines and industrial arithmetic. The instruction covers the same ground as the evening courses.

In the steam laboratory, of which the boiler-room equipment is a part, there are three 6x18-foot horizontal return-tubular boilers with pumps, damper regulator, pressure-reducing valves and all the necessary boiler-room appliances. The equipment of this laboratory comprises also, one 8x24-inch Cooper Corliss engine, used with one or two eccentrics, one 12x12-inch Ames engine coupled to a 75-kilowatt General Electric direct-current generator, one 8x10-inch Armington & Sims engine belted to a 17-kilowatt Westinghouse generator, one 4x4-inch Sturtevant engine coupled to a generator, one 3 and 6 by 5-inch compound piston-valve marine engine, one 8x10-inch Payne engine, used for plain slide- and riding-cutoff valve setting; one Miller engine, one small upright slide-valve engine, one small horizontal slide-valve engine, eight steam pumps of various makes, one Wheeler surface condenser, one air pump, one jet condenser, one small horizontal-tubular boiler, traps, damper regulators, pump governors, reducing valves and safety valves of standard makes.

These engines and pumps are so installed that they may be worked condensing or noncondensing, using either the surface or jet condenser.

In the gas-engine laboratory there are: One 9-horsepower Foos gas engine, one 6-horsepower Mietz & Weiss oil engine, one 10-horsepower Atlantic special two-cylinder, two-stroke gasolene engine, one 25-horsepower Johnson four-cylinder, four-stroke gasolene engine, one 5-horsepower Lathrop one-cylinder, two-stroke

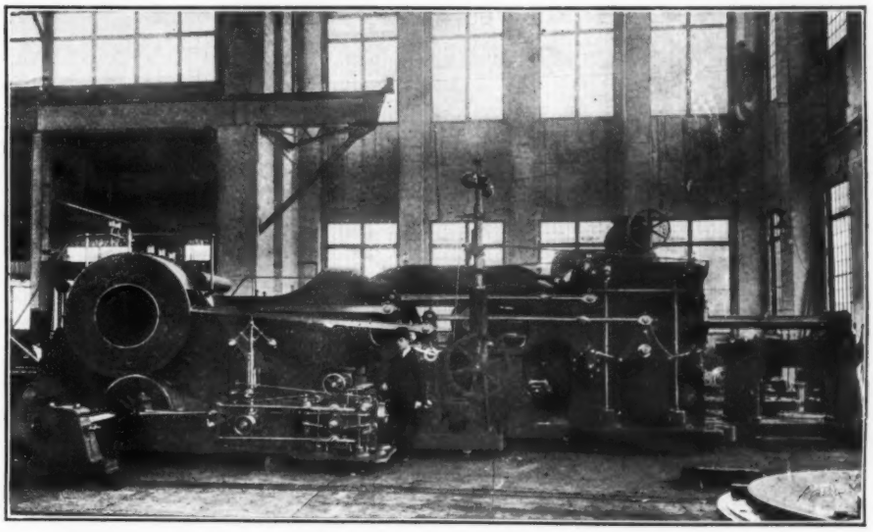


FIG. 3. ENGINE FOR FRANKLIN UNION ON THE ERECTION FLOOR AT THE SHOP

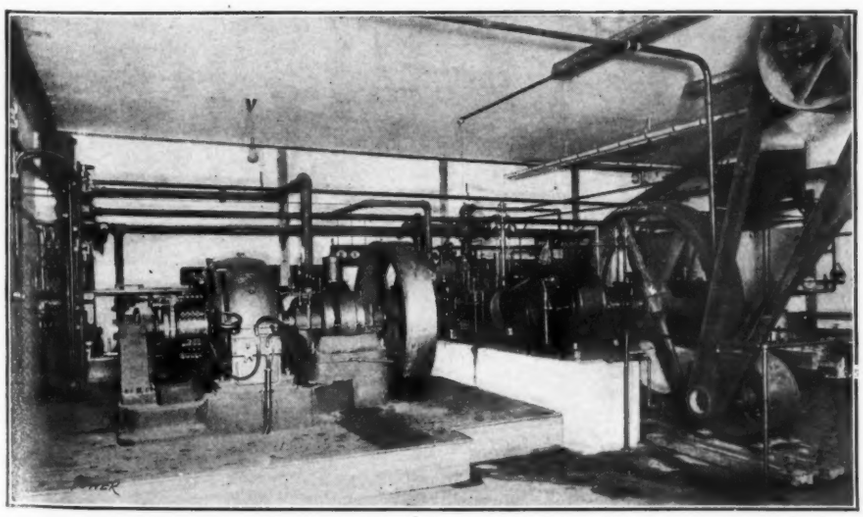


FIG. 4. ONE END OF STEAM-ENGINE LABORATORY

gasolene engine, one 3-horsepower Ferro one-cylinder, two-stroke gasolene engine, one 8-horsepower Atlantic three-cylinder, two-stroke gasolene engine, one 5-horsepower Wolverine one-cylinder, four-stroke gasolene engine, one 8-horsepower Clifton two-cylinder, four-stroke gasolene engine, one 2-horsepower Tufts one-cylinder, two-stroke gasolene engine.

All these engines are equipped with prony brakes, and with scales and tanks for weighing fuel. In addition there is an assortment of standard carbureters, timing devices and magnetos.

The electrical-laboratory equipment consists of one 45-horsepower direct-current Westinghouse motor coupled to a 30-kilowatt alternating-current Westinghouse generator, one 7½-kilowatt Westinghouse rotary converter, three 6-horsepower direct-current Westinghouse

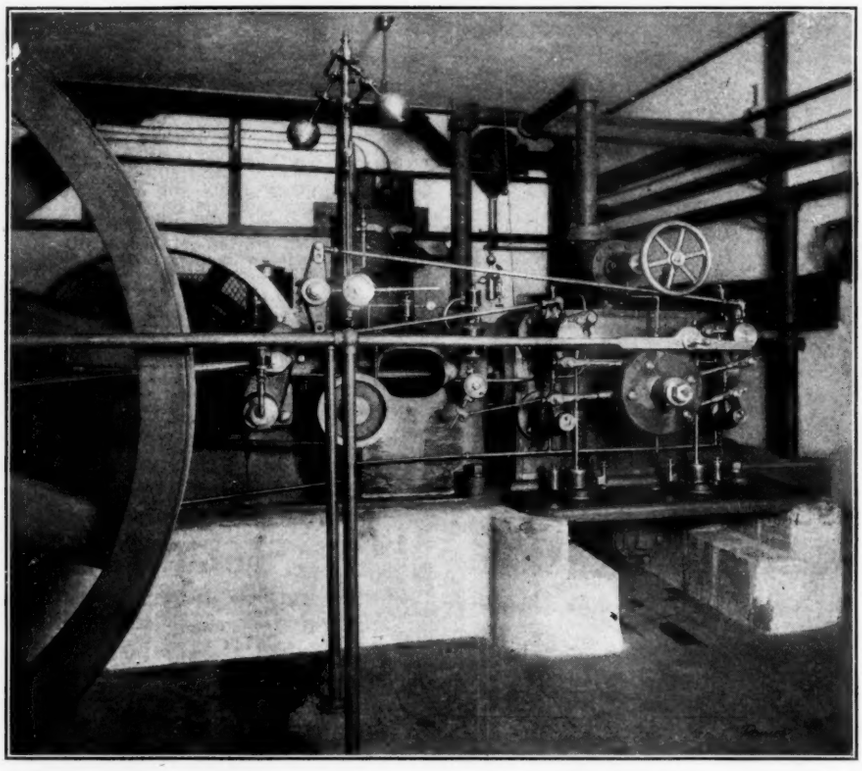


FIG. 5. COOPER CORLISS ENGINE, 8x24 INCHES

motors coupled to a 3½-kilowatt generator, one 5-horsepower Westinghouse variable-speed shunt motor with prony brake, one 5-horsepower direct-current Westinghouse motor with prony brake, one 5-horsepower Westinghouse variable-speed motor coupled to a Holtzer-Cabot 3-kilowatt generator, one 5-horsepower Westinghouse induction motor coupled to a 3-kilowatt Imperial electric generator, one 5-horsepower General Electric shunt-wound motor coupled to a 3¼-kilowatt Sprague generator, one 6-horsepower Edison bipolar motor, one 4½-horsepower 230-volt Crocker-Wheeler motor, one 5-horsepower General Electric motor coupled to a 3-kilowatt Holtzer-Cabot generator.

There are also banks of portable lamps, water rheostats, transformers, voltmeters and ammeters.

A glance at the course of instruction will show that the steam, mechanical and electrical courses constitute only a small part of the field covered by the curriculum; these, however, form the portion of greatest interest to engineers.

All of the apparatus in the steam- and gas-engine laboratories is directly under the supervision of George H. Bird, superintendent of the building, who is an indefatigable worker, spending the greater part of his waking hours in original investigation and experiment in the steam-engine laboratory.

One line of his investigation has been in the direction of finding the cost of leaks in the valves and pistons of steam engines. After ascertaining that the piston and valves of the 8x24-inch Cooper engine were tight, he drilled holes through them into which he fitted plugs, which could be removed to introduce any desired kind of a leak in the piston, steam valve or exhaust valve, individually or in concert. Loss from one or a combination of leaks was measured by weighing the water drawn from the Wheeler surface condenser.

Any problem in steam-engine construction or repairs is "nuts and raisins" to Mr. Bird, who never seems more interested than when he has possession of an old slide-valve engine and, surrounded by the class in steam engines and boilers, directs its reconstruction and repair, putting in new pins and brasses, adding a shifting eccentric or a riding cutoff, and so on.

Junk shops and second-hand machinery depots are ransacked for anything that will furnish work or instruction for the students who by actual hand work get, in one short term, an experience under able supervision that probably would not come to them in years of service in an ordinary power plant.

In an almost endless variety, problems in steam-engine installation, adjustment, operation and repairs are furnished. One group may use the Riehle testing machines on test pieces of boiler plate or concrete prepared by another group. A small class may today assemble an engine or a pump which was taken apart yesterday. Here a few are adjusting a riding cutoff designed by others while their own design will be taken in hand next week by others, and so on through the entire course, including boiler tests,

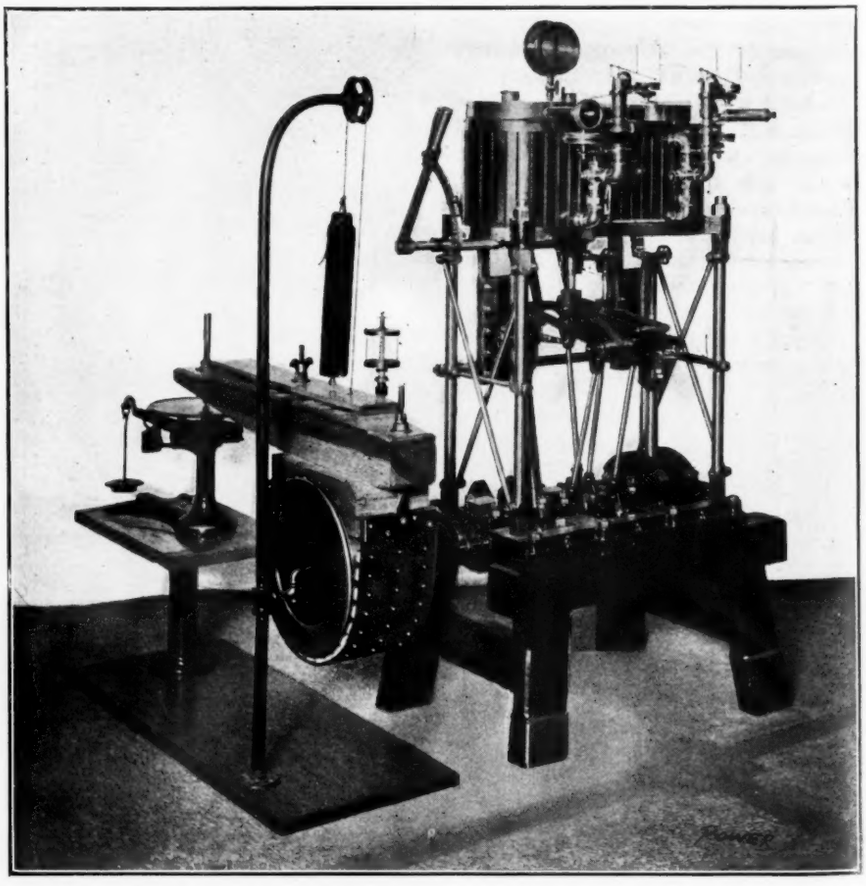


FIG. 6. MARINE COMPOUND ENGINE, 3 AND 6 BY 6 INCHES

FIG. 7. STEAM-ENGINE CLASS AT WORK

flue-gas analysis, design, operation and repairs of feed pumps, condensers, circulating and air pumps, lubricators, prony brakes, safety valves and every appliance connected with steam engineering. In the electric, gas and gasolene engine and the chemical laboratories the methods of teaching follow the same lines as closely as possible, making the instruction practical in every feature.

Examination question No. 19, selected at random from the list, is a fair example of the methods by which every student is required to demonstrate that he has an intelligent grasp of the subject which he has been studying.

It is interesting to watch the classes at their work; so intent are all in making every minute count for something gained. One of the illustrations shows a group at work in a corner of the engine room; some are at one thing and some at another, while at the left is seen a relic of other days—an old horizontal-tubular boiler built in 1862.

That part of the curriculum of greatest interest to engineers is embraced in steam engines and boilers, which covers two years and comprises lectures and laboratory practice for engineers, oilers and steamfitters. In the first year the subjects are boiler details; fittings, setting, installation, fuel and combustion; construction and operation of pumps and simple engines; setting plain slide valves. Those for the second year are Corliss and other automatic cutoff engines; heat and the generation and properties of steam; compound engines, condensers, indicators, elevators and refrigerating machinery.

This may and should be, if the student honestly desires the utmost advancement in knowledge and experience, supplemented by studies in machine construction which embrace machine-shop arithmetic, elementary mechanics, mechanical drawing, logarithms and the use of the slide rule, electricity in the shop, machine drawing, mechanics, mechanism, testing materials and machine design. He should also make selections from the course in industrial electricity which is intended to meet the needs of men working in the various electrical trades. The first year consists of lectures, recitations and laboratory work covering static and dynamic electricity, and magnetism, which every student must understand before he can handle intelligently any type of modern electrical machinery. The course includes instruction in figuring electrical direct-current circuits, in drawing wiring diagrams, in the theory and wiring of commercial dynamos and motors, and in solving practical problems. The laboratory work involves experiments illustrating the principles brought out in the

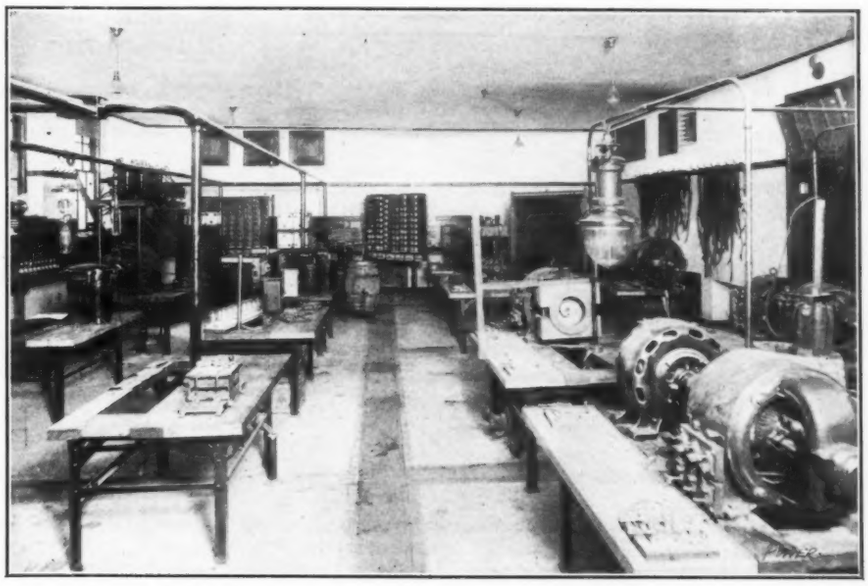


FIG. 8. ELECTRICAL LABORATORY

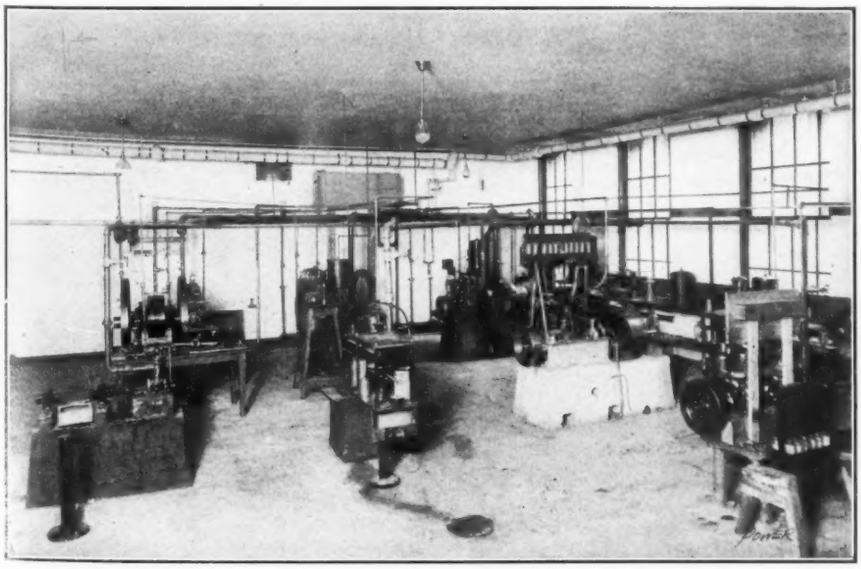


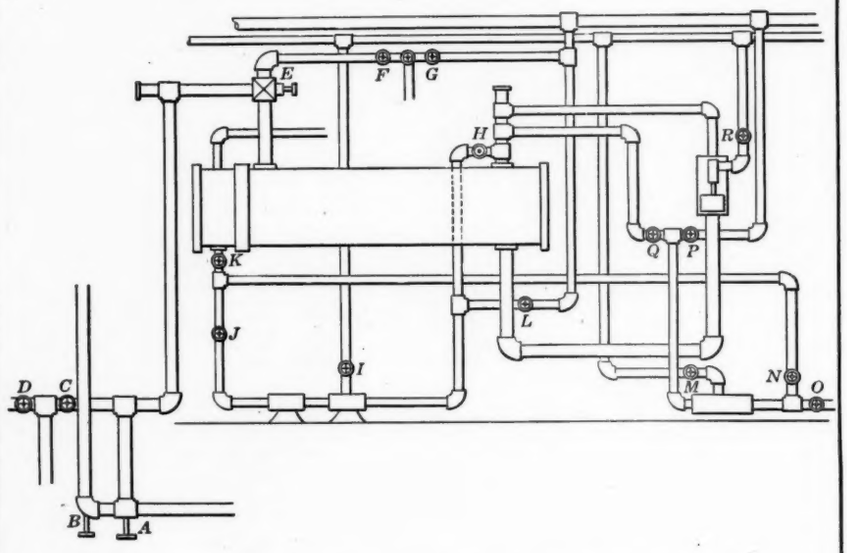
FIG. 9. GAS- AND GASOLENE-ENGINE LABORATORY

FRANKLIN UNION, Boston.

Steam Laboratory Practice.

Second Year

19. Condenser and steam piping in steam laboratory.



Make a list of the valves, showing which should be opened and which should be closed, in order to run the condenser with the Ames Engine, using the Davidson pump for the circulating water. Include the valves for both the air and circulating pumps, indicating the valves by the letters in the sketch.

Power

FIG. 10. SAMPLE EXAMINATION QUESTION

class room and the use of electrical measing instruments.

During the second year the laboratory work embraces the actual testing of direct-current and alternating-current motors, generators, arc lamps and transformers, and the use of measuring instruments. All the laboratory apparatus is of commercial size. The motors range from 5 to 50 horsepower and the generators from 3 to 30 kilowatts, and are typical of those produced by five different manufacturers. The laboratory work is supplemented by lectures, recitations and the solution of practical problems.

The course in industrial chemistry, though intended for young men employed in chemical-manufacturing plants, mills and drug houses, and for men who wish to acquire a practical knowledge of the principles and applications of chemistry, should not be passed by the engineering student if time can be afforded for even only a part of the course. The first year includes lectures and laboratory practice in elementary general chemistry. The second year includes qualitative and quantitative analysis. The third year offers an opportunity for instruction in commercial analysis and for specialization on industrial problems.

The entire course covers lectures, recitations and experiments in elementary chemistry, general chemistry, qualitative analysis, quantitative analysis, organic chemistry and commercial analysis.

Besides these there are complete and partial courses in sheet-metal drawing and mechanical drawing. Study in heating and ventilating can be followed to advantage by the practical steam and gasolene engineer as the power plant in the building is available for this work.

The "steam engines, boilers and firemen's class" is fortunate in being directly under the instruction of Cerlton A. Read, professor of steam engineering at the Worcester Polytechnic Institute, who is assisted in his work by George H. Bind, superintendent and chief engineer of the Franklin Union building; Edward H. Kearney, chief engineer of the John Hancock building, Devonshire street, Boston, George W. Hayes, chief engineer of the Puffer Manufacturing Company, Winchester, Mass., Frank G. Wright Factory building Trust Company, South Boston, and Robert E. Thayer, Massachusetts Institute of Technology, who are all able and eminent engineers in direct charge of important steam- and gas-engine plants in Boston and the immediate vicinity.

Walter B. Russell, a graduate of Massachusetts Institute of Technology, also graduate of and later instructor at the Pratt Institute, Brooklyn, N. Y., who was associated with C. W. Cross, superintendent of apprentices for the New York Central Railway lines and was in no small measure responsible for the efficient apprenticeship system of these roads, was selected by the board of managers for director of the Franklin Union. The steady improvement in the effectiveness of the instruction, the positions in industry secured by graduates and the fact that the applications for admission far exceed the capacity of the institution furnish ample evidence that no mistake was made in this selection.

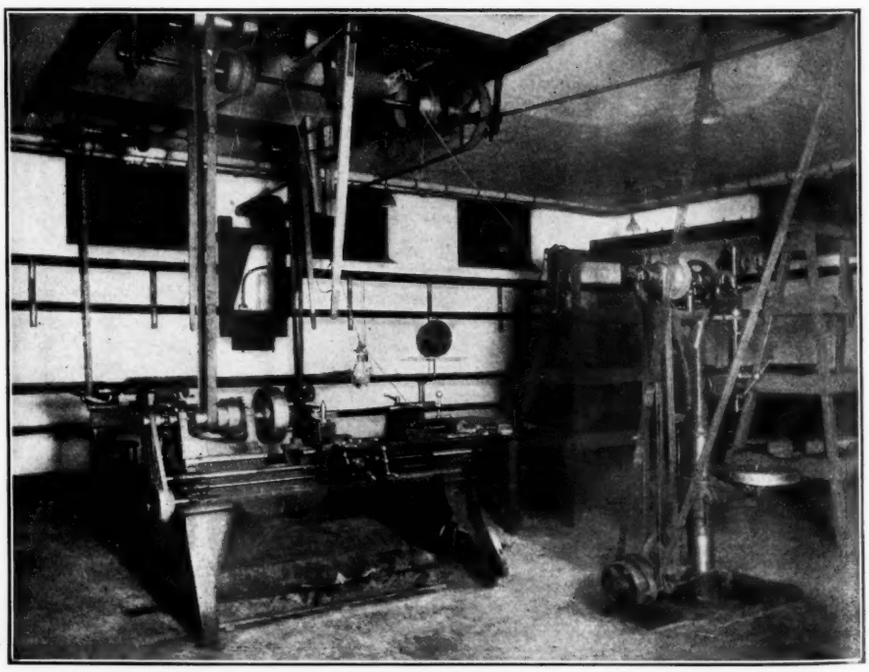


FIG. 11. A CORNER OF THE MACHINE SHOP

Development Releasing Valve Gear

By C. A. Tupper*

A review of the development of this type of valve gear from the days of Watt to the present time. Each distinctive gear is illustrated, its operation explained and its salient features pointed out. A second instalment will conclude the discussion of the releasing valve gears used in current practice.

D. K. Clark, in his work on "Steam Engines," is authority for the statement that the disconnecting valve gear invented in England by James Watt, for opening and closing poppet valves, as shown in Fig. 1, discloses the germ of the modern gear; and that Watt advocated, if he did not practise, the employment of the governor to vary the cutoff instead of wiredrawing the steam. From the explanation accompanying Fig. 1, however, it is evident that this gear was operated without either governor or wristplate.

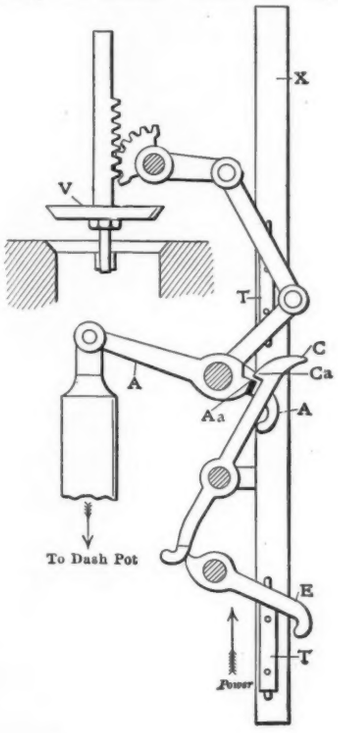


FIG. 1. ORIGINAL WATT GEAR

A A' = Drop lever which actuates the valve by connecting link, arm, rack and pinion, and is also connected to the dashpot rod.
Aa = Catch on *A*.
C = Hook.
Ca = Catch on *C*.
E = Trip lever.
T = Tappets.
V = Valve.
X = Rod connected to engine beam.

OPERATION

When *X* is moved in one direction by the engine beam, then by means of tappets *T* the opening and closing of the valve is caused, and in the opposite direction tappets cause the curved lever *E* to trip or liberate *Ca* on *C* from *Aa* on *A'*. The dashpot immediately draws *A* downward, to act either for opening or closing the valve.

Releasing or tripping mechanisms for valve gears were first brought out in 1841, by an American, Frederick E. Sickles, who in May, 1842, and September, 1845, obtained U. S. letters patent on "the combination of a cam, arm or wiper moved by an independent motion with a reciprocating trip and catch to liberate a weight, spring or other force that acts to close a cutoff valve." From this claim it would be inferred that the invention of Sickles covered the essential features of the liberating valve gears in use at the present time, and considerable confusion exists in the public mind as to the exact degree of credit due him.

The Sickles mechanism, as practically developed, appears to have been first utilized by an engineering firm in New York City in the motive power of a steamer named the "South America." It was applied to poppet valves lifted by cams. When the cam had lifted the valve stem to the desired point, a latch connection between the stem and the lifting mechanism was released and the valve closed independently by dropping. As the lifting mechanism descended, it

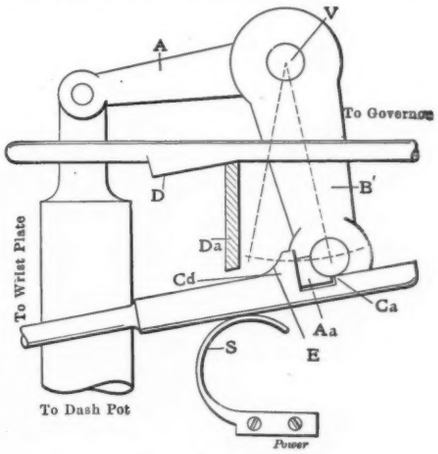


FIG. 2. FIRST GEORGE CORLISS GEAR

A = Drop lever, mounted on the valve stem which it actuates, and connected to the dashpot rod.
B' = Lever carrying catchblock and receiving its motion from the wristplate.
Aa = Catchblock on *B'*.
Ca = Catch on wristplate rod.
Cd = Stop on wristplate rod.
D = Incline plane or knock-off cam.
Da = Trip bolt.
E = Projection for tripping.
S = Spring.
V = Valve stem.

OPERATION

When *B'* is pulled in the direction of the wristplate, *Ca* engages *Aa*, thereby raising *A* until *E* comes in contact with *Da* forcing *E* away, thus causing *Ca* to release *B'*, *A* is then immediately drawn downward by the dashpot, closing the valve.

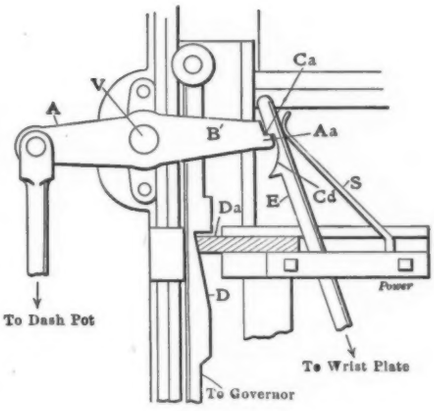


FIG. 3. SECOND GEORGE CORLISS GEAR

A = Drop lever mounted on the valve stem and connected to the dashpot rod. The valves are actuated by small rollers and toothed segments.
B' = Lever carrying catchblock and receiving its motion from the wristplate.
Aa = Catch on *B'*.
Ca = Catch on wristplate rod.
Cd = Stop on wristplate rod.
D = Incline plane or knock-off cam.
Da = Trip bolt.
E = Tripping surface on wristplate rod.
S = Spring.
V = Valve stem.

OPERATION

When *B'* is pulled in the direction of the wristplate *Ca* engages *Aa*, thereby raising *A* until *E* comes in contact with *Da* and forces *E* away; this causes *Ca* to release *B'*. *A* is then immediately drawn downward by the dashpot and closes the valve.

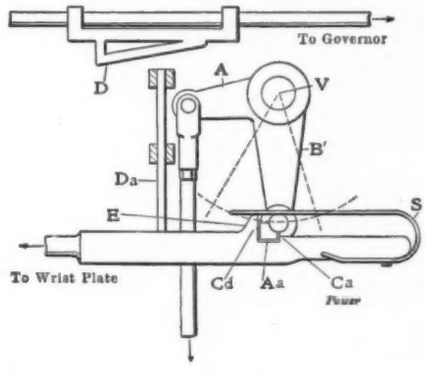


FIG. 4. THIRD GEORGE CORLISS GEAR

A = Drop lever or bell crank, mounted on the valve stem which it actuates, and connected to the dashpot rod.
B' = Lever carrying catchblock and receiving its motion from the wristplate.
Aa = Catchblock on *B'*.
Ca = Catch on wristplate rod.
Cd = Stop on wristplate rod.
D = Incline plane or knock-off cam.
Da = Trip bolt.
E = Projection for tripping.
S = Spring.
V = Valve stem.

OPERATION

When *B'* is pulled in the direction of the wristplate, *Ca* engages *Aa*, thereby raising *A* until *E* comes in contact with *Da* and forces *E* away, causing *Ca* to release *B'*, *A* is then immediately drawn downward by the dashpot and closes the valve.

*Manager of the Reliance Engineering and Equipment Company, Milwaukee, Wis.

displaced the latch; but after it had passed, the latch was forced forward into position to be caught again by the lifting mechanism on the next stroke. This latch release, however, could be adjusted only by hand, and the next step in the development of such mechanisms was to make them subject to the automatic control of a governor.

To Zachariah Allen is accredited the invention, in 1834, of an expansion gear depending upon the governor for its regulation; but the first engineer who caused the governor to act on a tripping gear was George H. Corliss, of Providence, R. I. His invention is usually dated from March 10, 1849, at which time he was granted a patent, which expired in 1870.

The characteristics of all Corliss valve gears may be said to consist of: First, the four separate steam-distributing parts, two for admission and two for exhaust, so arranged as to reduce clearance to a minimum; second, the disengagement of the external mechanism through the governor at the end of the steam admission periods, whereby the work of the engine is regulated and satisfactorily performed under relatively constant boiler pressure. To accomplish the required results it is necessary to use rotating valves which can be easily moved and reliably operated by a mechanism entirely exterior to the steam cylinder.

In this connection the first feature is the operation of the four valves from points on a wristplate, which is made to oscillate back and forth through a considerable angle by its connection with the eccentric, the arrangement being such that the steam valve will open rapidly as the engine passes its dead center and the exhaust valve on the opposite end of the cylinder will be opened wide before that point is reached. The valves usually work in diagonal pairs, the action of each pair being independent of the other.

The second feature is the release or trip of the steam-valve rods, by which the hold of the wristplate upon the valve is released and the valve is closed suddenly by a weight or spring. The differences in the design of this releasing mechanism distinguish the various Corliss engines from one another; but it is an essential characteristic of all forms that the adjustment of the gear be made by the governor, so that the speed of the engine will automatically vary the length of admission by causing cutoff when the trip occurs. The exhaust valves are positively connected to the wristplate, so that release and compression will be constant for any given valve setting, while cutoff and expansion vary according to the work of the engine.

A third feature common to Corliss gears is the closing of the valve, when disconnected from the wristplate, by means of a weight or spring attached to a dashpot; although other methods are also used.

The development of these features from the earliest designs, and the differ-

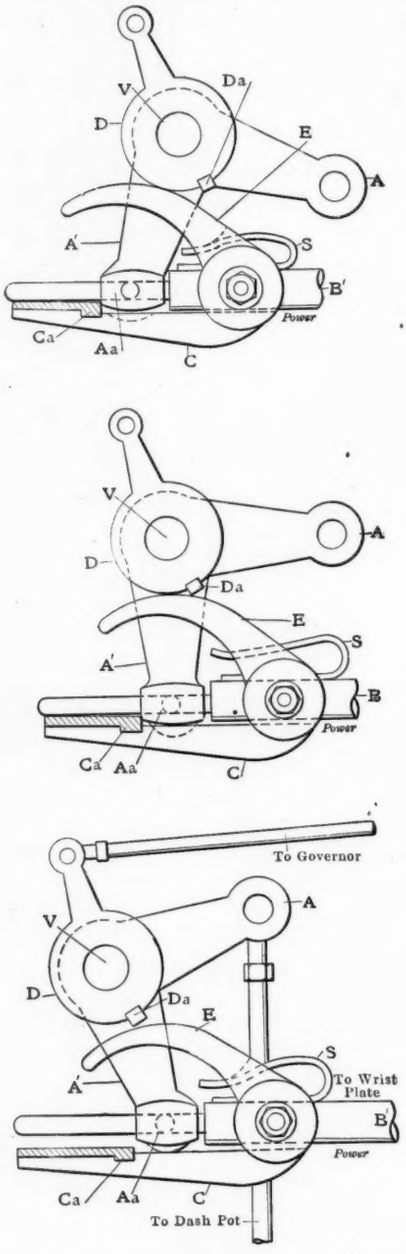


FIG. 5. CRAB-CLAW GEAR OF GEORGE CORLISS IN OPERATING POSITIONS

$A\ A'$ = Drop lever or bell crank, keyed to the valve stem which it actuates, and connected to the dashpot rod.
Aa = Block carried by A'.
$B'\ C\ E$ = Crab-claw from which this type of gear takes its name. B is a rod, deriving its motion from the wristplate, which carries the hook C and tripping lever E, the two last named being in one piece.
Ca = Catchblock on C.
D = Knock-off cam, loosely mounted on on the outer end of the valve stem. The position of this cam is determined by the governor.
Da = Projection for tripping.
E = Trip lever, as explained above.
V = Valve stem.
S = Spring.

OPERATION

When B' is pulled toward the wristplate, Ca engages Aa, thereby raising A until E comes in contact with Da and is forced away. This depresses C sufficiently to release Aa, and A is immediately drawn downward by the dashpot, closing the valve.

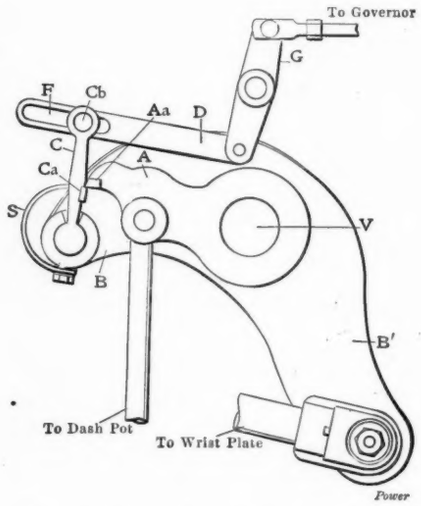


FIG. 6. LATER GEORGE CORLISS GEAR

A = Drop lever or crank arm, keyed to the valve stem which it actuates, and connected to the dashpot rod.
Aa = Block carried by A.
$B\ B'$ = Curved lever carrying, at the end of the shorter arm B, a latch playing on a cylindrical socket joint. This lever receives its motion from the wristplate.
C = Latch.
Ca = Block carried by C.
Cb = Pin sliding in D (trip roller).
D = Slotted bar, performing a function similar to that of the knock-off cam, now generally used. This is supported at one end by the pin Cb, and at the other end by the arm G, the position of which, and consequently of F, is determined by the governor.
F = Slot in D, the position of which controls the points of release and cutoff.
G = Connection to governor.
S = Spring holding hook in its normal position.
V = Valve stem.

OPERATION

When B' is pulled toward the wristplate Ca engages Aa, and raises A until Cb slides to the end of the slot in D, moving C far enough outward to release A, which is immediately drawn downward by the dashpot and closes the valve.

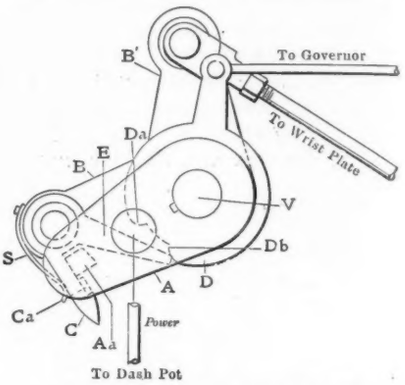


FIG. 7. REYNOLDS-CORLISS GEAR

A = Drop lever or crank arm, keyed to the valve stem which it actuates, and connected to the dashpot rod.
Aa = Catchblock on A.
$B\ B'$ = Bell crank, which carries hook C and tripping lever E. This bell crank receives its motion from the wristplate.
C = Hook.
Ca = Block carried by hook.
D = Knock-off cam mounted on the valve stem between A and B. The position of this cam is determined by the governor.
Da = Projection for tripping.
Db = Projection for safety stop.
E = Trip lever.
S = Spring.
V = Valve stem.

OPERATION

When B' is pulled in the direction of the wristplate, Ca engages Aa, thereby raising A until E comes in contact with Da. This forces E away and causes C to release A, which is immediately drawn downward by the dashpot and closes the valve.

ence in detail at the present time, is briefly discussed and illustrated in the following: It will also be made manifest, as far as practicable, to what individual minds the important variations in type are principally due.

Fig. 2 represents the first Corliss gear, while Figs. 3 and 4 show the salient points of the later forms that led to the introduction by Corliss of the celebrated "crab-claw gear," illustrated in Fig. 5.

From this point the development of releasing gears proceeded independently along quite a number of parallel lines, which may be treated in two distinct divisions, namely, trip gears and cam and roller gears.

In the first of these, release is effected by one leg of the hook sliding over the cam, and in the other the same result is attained by means of a roller working upon a cam. The relative merits and demerits of the two types, depending upon their adaptability to various kinds of service, are briefly indicated, but the reader will be left to judge these points chiefly for himself.

Fig. 5, showing the crab-claw gear previously alluded to, represents the first Corliss releasing mechanism to be extensively employed over a long period of time, and its appearance marked a distinct advance in the design of steam engines. For the slow speeds then in use, the device was well adapted.

In Fig. 6 is illustrated the latest gear designed by Corliss, which was used by the Corliss Steam Engine Company and later by its successor, the International Power Company, now the American & British Manufacturing Company.

The first important outcome from the crab-claw gear made by an inventor other than Corliss was the Reynolds-Corliss gear brought out by Edwin Reynolds in 1877, a distinguishing feature of which lies in the substitution for the crab claw of a V-shaped hook, as shown in Fig. 7. The advantage of this mechanism over the crab-claw gear is that the strains on the valve stem are greatly reduced. The hook takes hold of the lifting arm at the same distance from the center of the stem as does the dashpot, or very close to it, practically doing away with the bending moment due to the pull of the dashpot. The stem is mainly subjected to torsional strains caused by the friction and inertia of the valve. In the crab-claw gear, which is now a thing of the past, the stem had to withstand the bending moment due to the pull of the dashpot, also the forward strain resulting from the resistance of the valve; this caused the valve-stem bearing in the bonnet to wear rapidly.

The crab claw was also heavy and was, therefore, adapted only to slow running engines. It required a stiff spring to bring it into engagement with the steam lever, as the whole weight of the claw had to be lifted. In the Reynolds gear, however, the weight of the hook directly assists in the operation, therefore it requires only a very light spring. Moreover, in this gear all the edges of the steel on the hook or steam arm can be used as working edges, which is not the case in the crab-claw gear.

Since Edwin Reynolds brought out his gear, most Corliss engine builders, with the exceptions noted in the following remarks, have adopted his design outright or with slight modifications. At the pres-

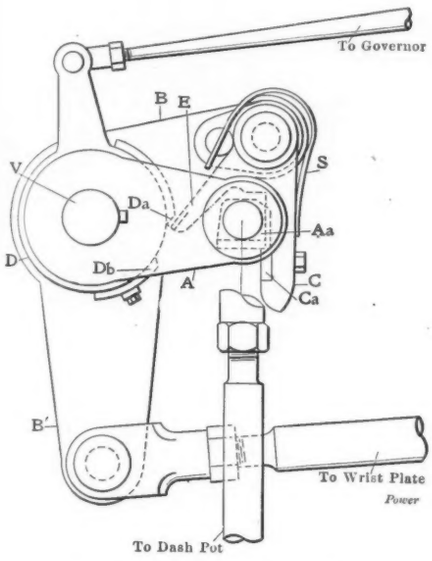


FIG. 8. REYNOLDS-CORLISS GEAR

A = Drop lever or crank arm, keyed to the valve stem which it actuates, and connected to the dashpot rod.
Aa = Catchblock on A.
$B\,B'$ = Bell crank, which carries hook C and tripping lever E. This bell crank receives its motion from the wristplate.
C = Hook.
Ca = Block carried by hook.
D = Knock-off cam mounted on the valve stem between A and $B\,B'$. The position of this cam is determined by the governor.
Da = Projection for tripping (operating cam).
Db = Projection for safety stop (safety cam).
E = Trip lever.
S = Spring.
V = Valve stem.

OPERATION

When B' is pulled in the direction of the wristplate, Ca engages Aa, thereby raising A until E comes in contact with Da (as shown in the figure). This forces E away and causes C to release A, which is immediately drawn downward by the dashpot and closes the valve.

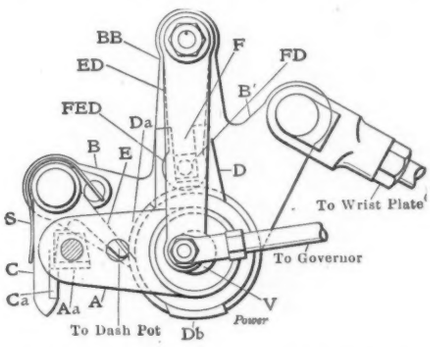


FIG. 9. REYNOLDS "WORLD'S FAIR" GEAR

A = Drop lever on crank arm, keyed to the valve stem which it actuates, and connected to the dashpot rod.
Aa = Catchblock on A.
B, B', BB = Three-arm steam lever. B carries hook C and spring S; B' is connected to the wristplate; $B\,B$ holds floating lever $E\,D$ and arm $F\,E\,D$ pivoted on the stud.
C = Hook.
Ca = Catchblock on C.
D = Slotted arm on cam sleeve (detaching cam). The position of this cam is determined by the action of mediums $E\,D$, $F\,E\,D$ and $F\,D$ (the latter slides up or down in F).
Da = Projection for tripping (operating cam).
Db = Projection for safety stop (safety cam).
$E\,D$ = Floating lever pivoted on stud, which stud projects horizontally forward from the upper extremity of $B\,B$. The movement of this lever is controlled by the governor.
F = Slot in D, the position of which controls points of release and cutoff.
$F\,D$ = Sliding block on $F\,E\,D$.
$F\,E\,D$ = Arm cast in one piece with $E\,D$ and suspended from far end of sleeve on $E\,D$. This sleeve projects horizontally back from the upper extremity of $E\,D$. The arm holds the block $F\,D$ at its lower extremity and is pivoted on a stud.
S = Spring.
V = Valve stem.

OPERATION

When B' is pulled in the direction of the wristplate, Ca engages Aa, raising A until E comes in contact with Da. This forces $E\,C$ outward and causes C to release A, which is immediately drawn down by the dashpot and closes the valve.

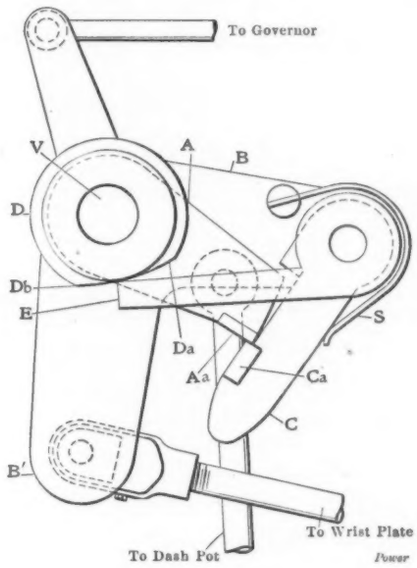


FIG. 10. FRASER & CHALMERS GEAR

A = Drop lever or crank arm mounted on the valve stem which it actuates, and connected to the dashpot rod.
Aa = Block carried by A.
$B\,B'$ = Bell crank which carries a hook C on its inner side and a tripping lever E on its outer side. This bell crank receives its motion from the wristplate.
C = Hook.
Ca = Block carried by C.
D = Knock-off cam loosely mounted on the outer end of the valve stem, the position of which cam is determined by the governor.
Da = Projection for tripping.
Db = Projection for safety stop.
E = Trip lever.
S = Spring.
V = Valve stem.

OPERATION

When B' is pulled in the direction of the wristplate, Ca engages Aa, thereby raising A until E comes in contact with Da. This forces E away and causes C to release A, which is immediately drawn downward by the dashpot and closes the valve.

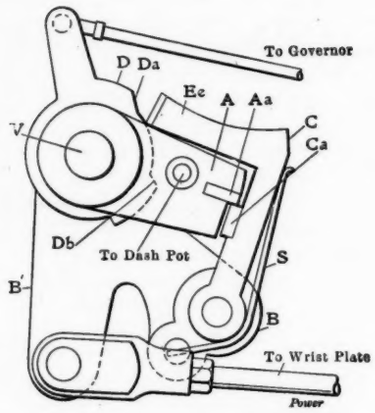


FIG. 11. HOFFMAN & BILLINGS (SEDERHOLM) GEAR

A = Drop lever or bell crank, keyed to the valve stem inside of the outer bonnet bearing which it actuates, and connected to the dashpot rod.
Aa = Block carried by A.
$B\,B'$ = Double arm, which carries hook C. This arm receives its motion from the wristplate.
C = Hook journaled in B'.
Ca = Block carried by C.
Ec = Right angular extension and support of lever C, in position approximately horizontal.
D = Knock-off cam mounted on the valve-stem bearing, the position of this cam is determined by the governor.
Da = Rise to a surface concentric with groove surface.
Db = Rise to a surface concentric with groove surface.
S = Spring.
V = Valve stem.

OPERATION

When B' is pulled toward the wristplate, Ec ascends along the groove in D, keeping Ca and Aa in the relative position shown, until Ec comes in contact with Da, then it suddenly deviates from the valve-stem center and forces C outward, disengaging the blocks. This releases A, which is immediately drawn downward by the dashpot and closes the valve.

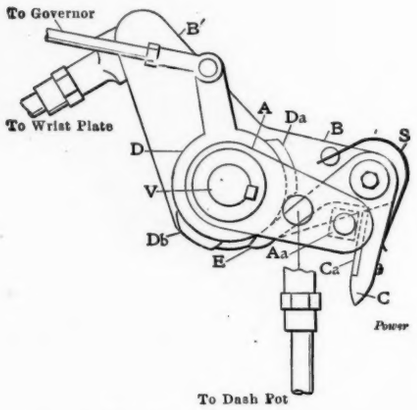


FIG. 12. MURRAY GEAR

A = Drop lever or crank pin, keyed to the valve stem which it actuates, and connected to the dashpot rod.
Aa = Catchblock on A.
$B\,B'$ = Bell crank, which carries hook C and lever E. This bell crank receives its motion from the wristplate.
C = Hook.
Ca = Block carried by hook.
D = Knock-off lever mounted on the angular bracket between A and $B\,B'$, the position of this lever is determined by the governor.
Da = Knock-off cam.
Db = Safety knock-off cam.

OPERATION

When B' is pulled in the direction of the wristplate, Ca engages Aa, thereby raising A until E comes in contact with Da. This forces E away and causes C to release A, which is immediately drawn downward by the dashpot, and closes the valve.

ent time the essential differences in the Corliss valve gears used by the great majority of builders are mainly due to workmanship and to designing the parts with more or less ample wearing surfaces.

The form shown in Fig. 7 has always proved satisfactory in operation and is similar to that now used by the Fulton Iron Works. As a standard it has been very closely adhered to by other leading builders, a fact which will be recognized at once by comparing it with the next few gears illustrated.

Fig. 8 is a modified form of that shown in Fig. 7, and has been used within re-

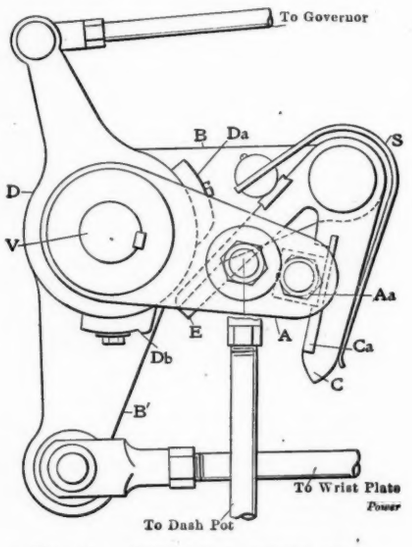


FIG. 13. GRIFFITH & WEDGE GEAR

A = Drop lever or crank arm, keyed to the valve stem which it actuates, and connected to the dashpot rod.
Aa = Catchblock on A.
$B\,B'$ = Bell crank which carries hook C and tripping lever E. This bell crank receives its motion from the wristplate.
C = Hook.
Ca = Block carried by hook.
D = Knock-off cam mounted on the valve stem between A and $B\,B'$. The position of this cam is determined by the governor.
Da = Projection for tripping (operating cam).
Db = Projection for safety stop (safety cam).
E = Trip lever.
S = Spring.
V = Valve.

OPERATION

When B' is pulled in the direction of the wristplate, Ca engages Aa, thereby raising A until E comes in contact with Da. This forces E away and causes C to release A, which is immediately drawn downward by the dashpot and closes the valve.

cent years by Allis-Chalmers Company, for whom Edwin Reynolds long served as chief engineer. This gear is adapted to both medium- and long-range cutoff. Its application to the latter purpose is clearly indicated by Hubert E. Collins in his book on "Valve Setting," in which he states that the long-range gear is designed to give a maximum cutoff. The essential features of the steam valves are that they have a negative lap or opening when in mid-position, the cutoff being made entirely by the governor through the knock-off cam. In the engine which was built by Edwin Reynolds for the Columbian Exposition, an auxiliary eccentric operated levers on the governor in such a manner as to cause the knock-off block to follow the hook until cutoff occurred at the latest practicable point in the stroke; but in all essential details

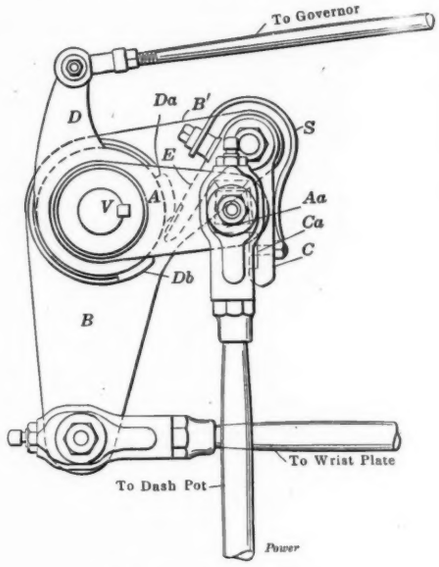


FIG. 14. COOPER GEAR

A = Drop lever or steam crank, keyed to the valve stem which it actuates, and connected to the dashpot rod.
Aa = Block-pin block carried by A.
$B\,B'$ = Bell crank, which receives its motion from the wristplate and carries hook C.
C = Hook.
Ca = Pick-up block carried by hook.
D = Knock-off cam mounted on the valve stem between A and $B\,B'$. The position of this cam is determined by the governor.
Da = Knock-off clip.
Db = Safety clip.
E = Trip lever.
S = Spring.
V = Valve stem.

OPERATION

When B' is pulled in the direction of the wristplate, Ca engages Aa, thereby raising A until E comes in contact with Da. This forces C away, thus causing C to release A, which is immediately drawn downward by the dashpot and closes the valve. When the governor reaches its lowest position, the projection Db prevents Ca from engaging Aa and keeps the valve closed. Similarly when the governor reaches its highest position, Da is moved around until Ca is kept from engaging with Aa and opening the valve.

the releasing mechanism embodied the standard Reynolds-Corliss design. This gear is shown in Fig. 9.

Practically identical with Fig. 8 is the gear used by the Bates Machine Company, except for the fact that the wristplates are eliminated and the motion imparted directly by the eccentric rod, a feature which was also used by Reynolds.

The Bates Machine Company at one time employed a form of valve gear which differed radically from any of those described in this article, a folding mechanism being substituted for the usual hook or crab-claw rig; but it possesses merely historical interest and is not of sufficient importance to be illustrated here.

Very similar to Fig. 7 is the gear illustrated in Fig. 10, which was formerly used, among others, by Fraser & Cha!-

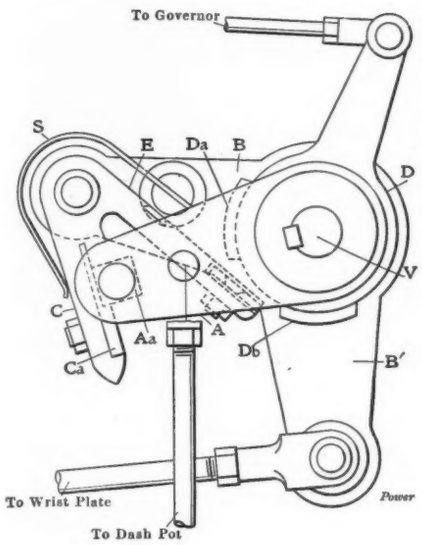


FIG. 15. HEILMAN GEAR

A = Drop lever or crank arm, keyed to the valve stem which it actuates, and connected to the dashpot rod.
Aa = Catchblock on A.
$B\,B'$ = Bell crank, which carries hook C and tripping lever E. This bell crank receives its motion from the wristplate.
C = Hook.
Ca = Block carried by hook.
D = Knock-off cam mounted on the valve stem between A and $B\,B'$; its position is determined by the governor.
Da = Projection for tripping (operating cam).
Db = Projection for safety stop (safety cam).
E = Tripping lever.
S = Spring.
V = Valve stem.

OPERATION

When B' is pulled in the direction of the wristplate, Ca engages Aa, thereby raising A until E comes in contact with Da. This forces E away and causes C to release A, which is immediately drawn downward by the dashpot and closes the valve.

mers, of Chicago. In operation it is practically the same. A distinguishing feature of the engines upon which it has been used lies in the fact that the dashpots are set at a slight deviation from a right angle with the cylinder foot. It was claimed by the builders, whose plant has since been merged into the works of another company, that this position allows greater leverage on the point of the hook when raising the plunger of the dashpot and opening the valves, and at the same time affords the plunger greater leverage over the valve during the first part of its downward movement when closing the valve, thus insuring a very rapid closing of the valves and consequently a quick and sharp cutoff.

Fig. 11 shows a gear invented by E. T. Sederholm in 1885 for the Hoffman & Billings Manufacturing Company, of Milwaukee, which later appears to have been used by the Rarig Engineering Company. In this the drop lever is keyed on the valve stem inside of the outer bearing of the bonnet. The knock-off cam is mounted on the bonnet and projects sideways in such a manner that the hook comes in contact with it. This gear is noteworthy chiefly as being the first to have the valve stem supported at its outer end.

Fig. 12 is a sketch of the gear made by the Murray Iron Works. A feature of this is the fact that the knock-off lever is fitted with double cams for use with an improved automatic safety stop.

Fig. 13 shows the gear used by the Griffith & Wedge Company; and Fig. 14 has been sketched from the mechanism shown in an engraving of one of the C. & G. Cooper Company's engines. Fig. 15 illustrates the releasing mechanism employed by the Heilman Machine Works, and Fig. 16 is the Frick Company's gear.

These have all been successful in operation but follow so closely the standard design of Fig. 7 as to require no extended comment. Among other gears of the same general design are those which have been used by the Hooven, Owens, Rentschler Company; the William Todd Company; the Lane & Bodley Company; Lake Shore Engine Works; Knowlson & Kelley; St. Louis Iron and Machine Company; Watertown Engine Company; Robert Wetherill & Co.; H. N. Strait Manufacturing Company and Wellman-Seaver-Morgan Company.

(Other gears in common use will be described in next week's number.)

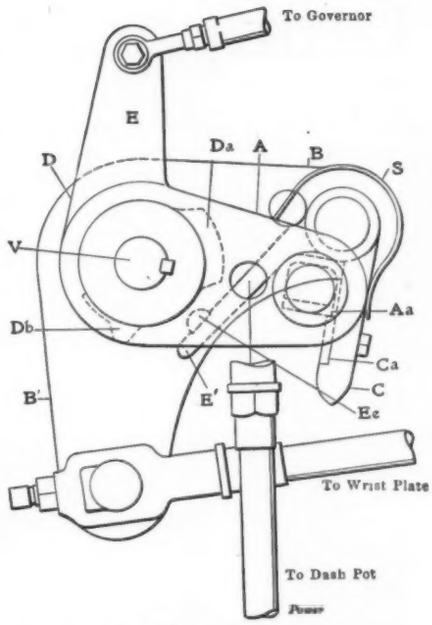


FIG. 16. FRICK GEAR

A = Drop lever or crank arm, keyed to the valve stem which it actuates, and connected to the dashpot rod.
Aa = Catchblock, which is a part of A.
$B\,B'$ = Bell crank, which carries the hook or latch C and receives its motion from the wristplate.
C = Hook.
Ca = Block carried by hook.
D = Knock-off cam mounted on the valve bonnet between A and $B\,B'$. The position of this is determined by the governor.
Da = Projection for tripping (operating cam).
Db = Projection for safety stop (safety cam).
E = Trip lever.
E' = Part of C.
Ec = Knock-off button on E'.
S = Spring.
V = Valve stem.

OPERATION

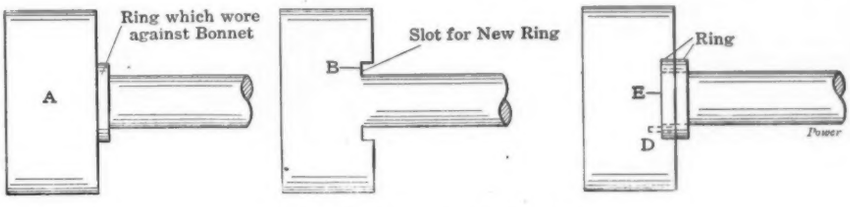
When B' is pulled in the direction of the wristplate Ca engages Aa, thereby raising A until Ec comes in contact with Da. This forces Ec away, thus causing C to release A, which is immediately drawn downward by the dashpot and closes the valve.

Corliss Valve Stem Repair

While talking shop with an engineer at one of the cotton mills located at Anniston, Ala., a method of repairing the valve stem of the Corliss engine was shown the writer, the original design of which is illustrated at A in the accompanying illustration. The collar, originally made solid with the valve stem, was designed to have a bearing against the valve-stem bonnet, but gave trouble from wearing, which allowed considerable end play to the valve.

In order to eliminate this trouble, the engineer turned off the original collar and cut a recess in the head of the valve stem, as shown at B, in which he fitted a ring of soft steel so that the outer edge came about even with the edge of the valve-stem head. Another ring of the same size was made an easy fit on the valve stem, to form a bearing with the ring E, set in the head, both being of the same size as the original ring on the stem, so as to fit in the recess in the bonnet.

By this arrangement the wear is now removed from the bonnet and placed on the two rings, which are easily removed when worn, thus eliminating the expense of a new valve stem. The inner ring is prevented from turning by the small dowel pin shown at D.



SHOWING VALVE-STEM REPAIR

Compact Condensing Installation

By Warren O. Rogers

In a small plant a change from reciprocating engines to turbines was made and it was decided to install condensers. It was necessary to economize in floor space, so the type of condensing unit shown in the illustrations was selected.

The power plant of the Bristol (Tenn.) Gas and Electric Company is not noted for its size, but it ranks among the pioneers in the use of the new Leblanc condenser, which, although No. 13, has been giving the best of satisfaction.

The main generating units consist of two 300-kilowatt, three-phase, 60-cycle generators direct connected to Westinghouse turbines. The most interesting feature of the plant, however, is the condenser installation. When it was decided to put in turbine units to supplant the reciprocating engines, the type and design of condenser had to be considered.

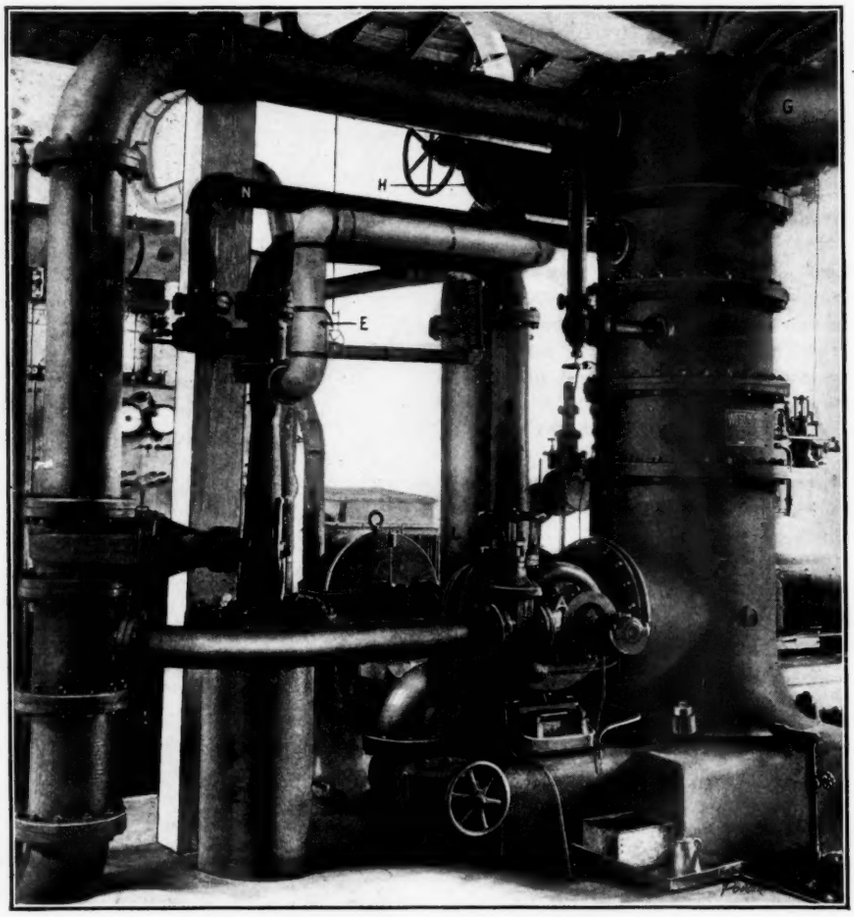


FIG. 1. LEBLANC CONDENSER IN BRISTOL PLANT

It was decided to install the Leblanc condenser shown in Fig. 1. It was located at the head end and midway between the two turbines. Instead of occupying a large floor space and requiring several foundations for the air pump and other auxiliaries, a light cement foundation was all that was required, and the condenser was placed upon it as shown.

When the condenser is in operation the water and air are removed separately by means of a pair of small turbine-type rotors attached to a shaft extending through the casing in which the rotors are placed. This casing is connected to the lower portion of the condensing chamber and is made slightly larger than the exhaust opening of the turbine.

The air pump operates on a principle differing from usual condenser practice. A series of slugs of water, between which are small pockets of air drawn from the upper portion of the condenser body, are forced through the discharge nozzle. In passing through the small nozzle the air mixes with the water, but owing to the velocity at which the water is traveling, no air can return to the condenser.

The condensing water is taken from a nearby creek at a lift of 18 feet, and the water used in the air pump is drawn from the main inlet pipe by suction into an annular chamber *A*, which is overhung by the bucket of the pump rotor. As the water passes out of an outlet connecting with the pipe *B*, it is projected downward in the form of slugs, with the small pockets of air between, and the whole is carried to the nozzle *C*. This nozzle has an auxiliary nozzle *D*, to which is connected a steam pipe *E*. When the engineer is about to start up the condenser, steam is turned into the auxiliary nozzle to create sufficient vacuum (about 10 inches) to cause water to flow through the air pump, which is then started. If the water supply were taken from a point above the air pump, it would not be necessary to use the steam jet in starting the condenser.

Fig. 2 illustrates the only moving element in the condenser, the two rotors of the pumps. This rotor shaft is driven by a steam turbine, as shown at *T*, Fig. 1, but if desirable, a motor can be used. In the Bristol plant the turbine running the pumps has 30 horsepower capacity when running at 2500 revolutions per minute.

Referring to Fig. 1, the exhaust steam enters the condenser through either of the pipes *G* or *H*, depending on which turbine is being used. The cooling water enters through the pipe *J*, and is projected downward through a spray nozzle lo-

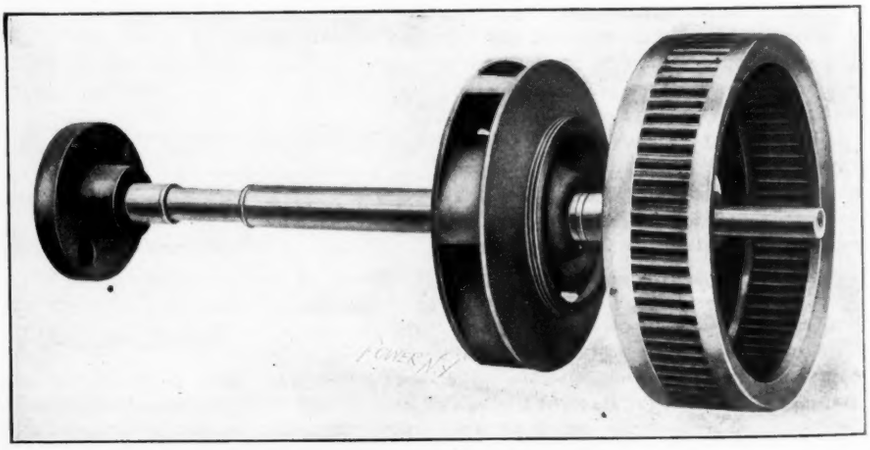


FIG. 2. ONLY MOVING ELEMENT IN THE CONDENSER

cated within the condenser in the section *R*. This injection water and condensed exhaust steam, which is drawn down and condensed by the water, after passing through the nozzle, flows to the centrifugal discharge pump *L* under a head of about 2.5 feet. The space *M* in the condenser, just below the nozzle and above the water passing through the discharge pump, is occupied by water vapor and air released from the injection water and from the exhaust steam. This space is connected to the air-pump nozzle *C* by means of the pipe *N*, and the vapor and air are removed as already described. The Bristol plant presents a good illustration of the advantages of this type of condensing unit.

Handy Chart for Barometer Readings

By G. A. Glick

Anyone who has worked with a calorimeter or with any barometer reading in inches of mercury will know the inconvenience incurred in changing these readings to a form in which they can be used. It is the object of the chart to facilitate such transformations, and by its use one is able to change inches of mercury to pounds per square inch; to find the corresponding boiling temperature at any barometer reading; and to find the altitude corresponding to any barometer reading. The chart is plotted only between 28 and 31.5 inches of mercury, for the reason that the larger number of calculations come within this range, and the small range permits considerable accuracy, that otherwise would not be obtainable. The scales used are all rather fine and this will permit close readings, which are liable to be more accurate than can be obtained on a slide rule.

A few constants are given below to permit calculations beyond the limits of the chart. With regard to altitude it may be said that, as a rough approximation, the pressure of the atmosphere decreases one-half pound per square inch for every 1000 feet of ascent, or in descending toward the center of the earth the barometer readings increase by 1 inch of mercury for every 900 feet drop. To change inches of mercury to pounds per square inch, the well known rule of multiplying the reading in inches by 0.4908 gives the corresponding pressure in pounds per square inch. Roughly speaking, pure water will boil at 1 degree Fahrenheit less for every 550 feet ascension up to an elevation of one mile, after which the increment becomes 560 feet.

The chart can be used interchangeably, that is, pounds per square inch can be used instead of inches of mercury to find the corresponding altitude and boiling point, or even the barometer reading, if it is desired. In this case all the values would have to be reduced to inches of mercury as a common standard. For example: Suppose the barometer reads 29.925 inches of mercury. Looking on the chart at this reading we find the corresponding pressure to be 14.68 pounds per square inch. The altitude corresponding to this barometer reading is 70 feet, and water will boil at 211.87 degrees Fahrenheit. Care must be taken that each reading is taken from the proper curve plotted for that condition.

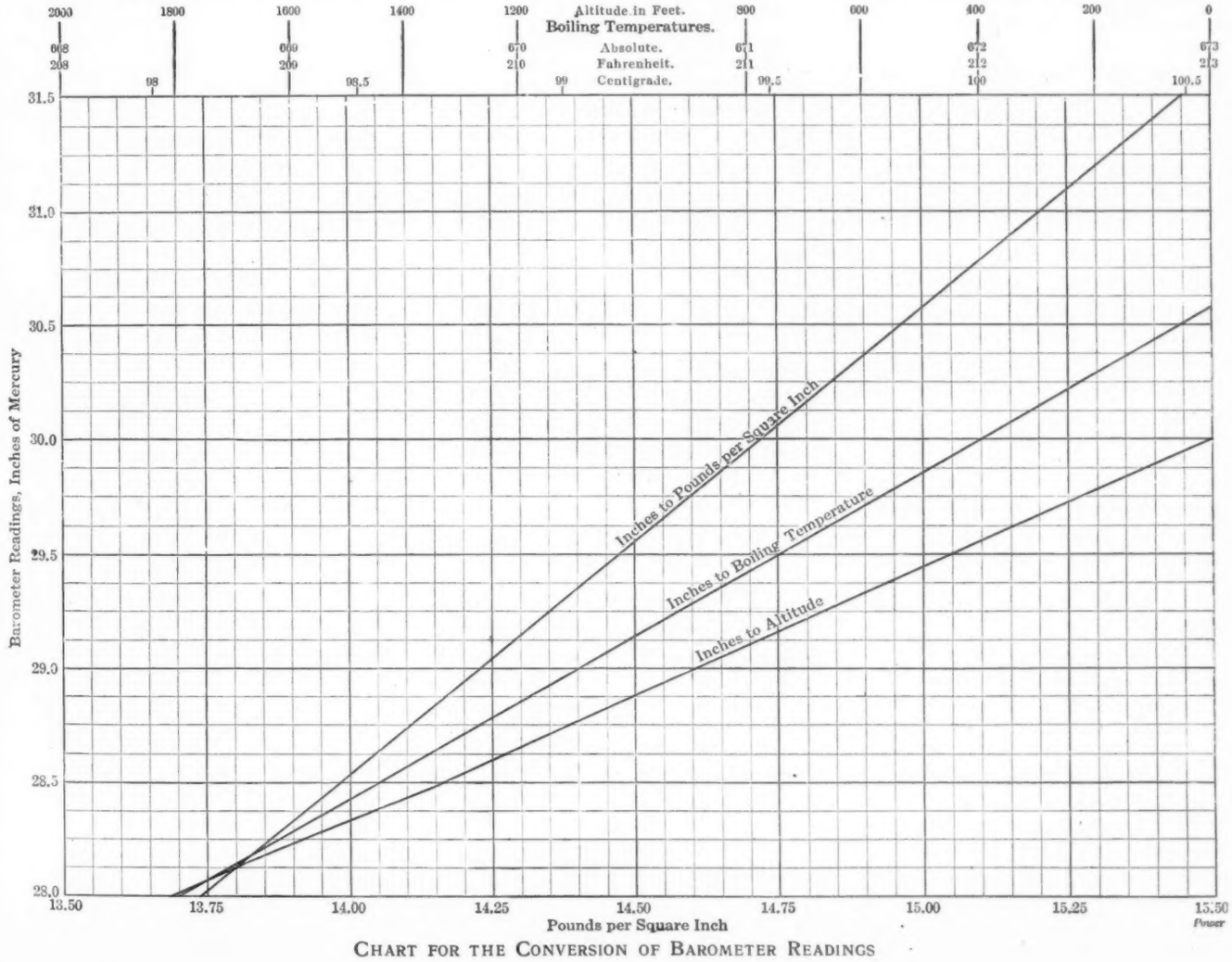


CHART FOR THE CONVERSION OF BAROMETER READINGS

Uncle Pegleg's Philosophy

By again using the platform car as an illustration Uncle Pegleg shows that a reaction nozzle must run as fast as the jet to get all the energy out of the water.

In fulfilment of his promise to explain why it is that a reaction nozzle must run as fast as the jet to get the energy all out, Uncle Pegleg produced at our next talk a sketch like Fig. 1.

"I've fixed this up," he said, "to represent the case where the water is taken aboard as fast as it is played out behind, so the process can be a continuous one. That tank we talked about the other day would run dry after a little and then the car would have to stop and take on dead water and store a lot of energy in it to get it into motion, and fool you about stopping it. Here's a long trough between the tracks and a scoop picking the water up

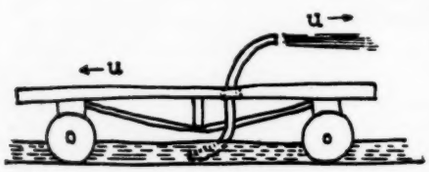


FIG. 1

the way they do it in locomotives. If there wasn't any friction the water would simply run in the front end and out the back as fast as the car ran. Is that clear?"

I could see that, with the exception of the little work needed to lift the water which he told me to forget along with the friction.

"Supposing the car to be running at u feet per second, you would have a jet coming out of the nozzle with a velocity of u, eh?"

I agreed to it.

"But it wouldn't be pushing the car any, would it? It would be coming out because something pushed the pipe through it, just as it would come out of the end of a straight tube that you pushed through the tank.

"Now, if you put in a pump here, Fig. 2, and hiked that water up to v feet per second you wouldn't have to do so much work on it to get it up to v feet as though you started with it standing still, would you? If it is already moving u feet in a second, all the motion you have to put into it with the pump is v-u feet a second. That's clear, isn't it?"

I allowed that it was.

"Well, now, it don't take so much force to accelerate a thing fifty feet a second as it does a hundred, does it?"

"No."

"And instead of taking $w\,v \div g$ pounds to get the jet up to a velocity of v feet per second as it would if the water started from rest, it would take only $w\ (v - u) \div g$ pounds."

I thought over his illustration of sliding the cake of ice on the pond, remembered that one pound of force would accelerate a pound of matter g feet per second and could see that to accelerate a weight w, a feet per second, would take a force equal to $w\,a \div g$. Of course, if the stuff was going with a velocity of u to start with and had to get up to v in a second, the acceleration was v-u. So far, so good.

"If the pump only has to push that hard on the water, the water will push back only that hard on the pump. Action and reaction are equal and opposite."

"Then the faster the nozzle moves the less it pushes," I said.

"Yes, in this case."

"I said that before and you said it didn't," I reminded him.

"But that was a different case. That nozzle wasn't taking in water in motion. It was drawing from a tank at rest with reference to itself," he replied.

"Now, let's see what we've got," he went on. "We have a jet reacting or pushing against the car with a force of $w\ (v - u) \div g$ pounds, and the car moves u feet per second, then the work done is as follows:

force × space = work

$$\frac{w(v-u)}{g} \times u = \text{work}$$

"Let us try it with some figures and see how it works out. Suppose the jet to be big enough to discharge 32 pounds a second, with a velocity of 100 feet a second, then the work done on the car would be:

$$\frac{w\ (v-u)}{g} \times u = \frac{32\ (100-u)}{32} = 100u - u^2$$

"Give u the values in the first column and you will get the values in the fourth column for the work expended on the car:

"Figure it out for 10 feet velocity of the car so you can see how it was done."

I put down

$u = 10$

$100 \times u = 1000$

$u^2 = 100$

$100u - u^2 = 1000 - 100 = 900$ foot-pounds

"You see," he said, "when the car don't move, that is, when $u = 0$ there is no work done on it. The number of foot-pounds of work that is done on the car runs from 900 per second at a velocity of 10 feet up to 2500 foot-pounds per second at 50 feet or half the velocity of the jet; after

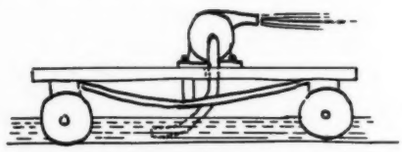


FIG. 2

this it runs down again as the fourth column shows until, when the velocity gets up to that of the jet, the energy has got back to nothing. Energy is the product of force and space. When the car is standing still the jet is pushing its hardest, but there is no energy absorbed by the car because there is no motion. When the car gets to going as fast as the jet there is plenty of motion but no force."

"It looks then as though it got the most power at half speed just like the impact wheel," I remarked.

"So it does."

"But you started in to prove that it got the most out when it ran as fast as the jet."

"No, I didn't, my boy. I started in to prove that it came nearest to getting all there was in the jet out of it when the nozzle ran as fast as the jet did. The faster the car runs the less work the pump can get in on the water for a given jet velocity, so the less there is to take out. Look at that fifth column. The energy in the water, due to the velocity with which it approaches the jet is $w\,u^2 \div 2\,g$, isn't it?"

"Well," I argued, "There isn't any energy in the water lying in the trough."

"Take it this way, then. The total energy of the jet is $w\,v^2 \div 2\,g$. See that?"

"Yes."

u	100 u	u^2	Work Done on Car.	Work Done on Jet.	Efficiency, Per Cent.
0	0	0	0	5,000	0
10	1,000	100	900	4,950	18.2
20	2,000	400	1,600	4,800	33.3
30	3,000	900	2,100	4,550	46.2
40	4,000	1,600	2,400	4,200	57.1
50	5,000	2,500	2,500	3,750	66.7
60	6,000	3,600	2,400	3,200	75.0
70	7,000	4,900	2,100	2,550	84.0
80	8,000	6,400	1,600	1,800	88.9
90	9,000	8,100	900	950	94.7
100	10,000	10,000	0	0	0

"Well, the pump didn't have to get up the full velocity v because the water would flow out of the nozzle with the velocity u due to the scoop. It was moving relatively to the nozzle with a velocity u and it had in it, relatively to the nozzle, $wu^2 \div 2g$ foot-pounds of energy per second."

I gave in.

"Then all the energy the pump had to put in was

$$\frac{w(v^2-u^2)}{2g} = \frac{32(100^2-30^2)}{2\times 32}$$

See that?"

I saw that it must be so if the thing over to the right of the equal mark was the difference between the other two. The old man told me to try it some time with figures instead of letters, and I did, and it came out the same.

"Just figure with that formula the energy put by the pump into the jet when the velocity of the car equals 30," he said.

I worked it out so, using the same values for v w and g as in the other columns:

$$\frac{wv^2}{2g} - \frac{wu^2}{2g} = \frac{w(v^2-u^2)}{2g}$$

$$\frac{10000-900}{2} = \frac{9100}{2} = 4550.$$

He showed me that this was the same that he got in the fourth line of his fifth column and said that all the other lines were figured the same way.

"You see," he said, "the amount of energy that the pump puts into a jet of that size at 100 feet runs from 5000 foot-pounds per second when the water coming to it has no velocity (the scoop no motion in the trough) down to nothing when the water is scooped in with the same velocity with which it runs out. (Remember that the quantity w that is taken in per second is the same in any case, but its velocity may be more or less.) Notice, too, that although the work done on the car becomes less after its speed exceeds that of the jet, the *proportion* of the work which is put into the jet by the pump (column 5), which is applied to the propulsion of the car (column 4) gets greater, the greater the speed. I have figured these in percentages in the last column by dividing the figures in column 4 by those in column 5, and multiplying by 100 to give it in percentage. When you get up near the velocity of the jet you are getting out the largest percentage of the work in the jet, but there wouldn't be much if you got the whole of it."

As he folded up his papers, he said: "Thought you had the old man stuck, didn't you?" and as I grinned he admitted, "Well, you did for a while."

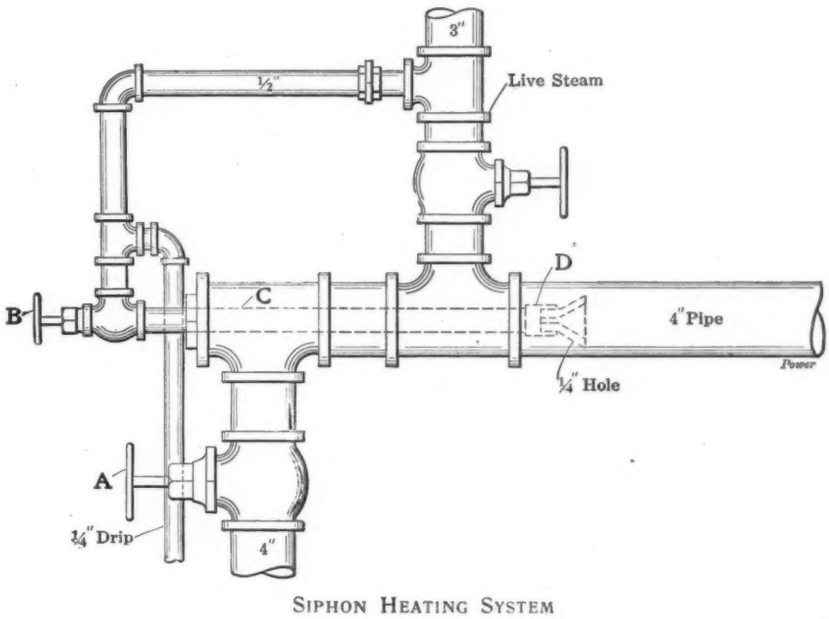
A Siphon Heating System

In the engine room of a cotton mill in the town of Anniston, Ala., a unique method of utilizing the exhaust steam from an engine unit is employed to heat the building which is a structure three stories high and several hundred feet long. The circulation of steam is effected without the aid of a vacuum pump or a back-pressure valve on the exhaust pipe.

When a heating engineer visited the plant, he suggested that a vacuum pump be installed to draw the exhaust steam through the heating coils in the factory, but the engineer decided that a better scheme could be utilized, and, therefore, devised a siphon system, which the "wise ones" claimed would not work; but it does.

A particular arrangement in this plant is that there are two exhaust pipes instead of one. The engine is made with a 14-inch exhaust outlet reduced to 12 inches from a tee placed between the cylinder and heater, and from the heater to the atmosphere. From the tee an 8-inch pipe extends out and up to a point above the roof, exhausting to the atmosphere. Just beyond the tee a 4-inch pipe is connected to the exhaust pipe which connects to the 1½-inch heating pipes in the mill.

The illustration shows the arrangement of the piping and the method employed to get the steam to circulate through the heating pipes. The 4-inch pipe from the engine exhaust line is fitted with a globe valve, in which is fitted a nipple to a 4-inch tee. In one end of the tee is a reducing plug, in which is fitted a ½-inch pipe. This pipe is connected to the 3-inch live-steam line, which also connects with the 4-inch pipe line leading to the factory. This live-steam line is used on the heating system when the engine is not running. The steam, when so used, is reduced to a pressure of 85 pounds per square inch.



SIPHON HEATING SYSTEM

The operation is simple. When exhaust steam is required for heating, the valves *A* and *B* are opened, the valve *A* being on the exhaust-steam line, and valve *B* regulating the live steam for the steam jet *D*. The ½-inch pipe *C* extends in past all joints and is fitted on the inner end with a coupling, in which a flared end piece is screwed. This nozzle has a ¼-inch hole through its center for the passage of live steam. The current of steam in issuing from the flared end draws exhaust steam from the exhaust pipe, which has from 1½ to 2 pounds back pressure, and forces it through the heating coils in the mill. By this method the engineer overcame the necessity of purchasing a vacuum pump, and at the same time obtained most satisfactory results with the steam jet.

The propensity of English builders of gas engines to cling to the hit-and-miss method of governing is manifest in the British section of the Brussels Exposition.

Elements of Compression System

By F. E. Matthews

The principles of operation of the compression refrigerating system are explained and the essential members of the direct-expansion and brine systems illustrated. Systems with semi-automatic and complete automatic control are given attention.

Fig. 1 is a diagrammatic representation of the essential members of a complete compression-refrigerating system in which *E* represents the direct-expansion coil in which the working medium is evaporated as in the test tube, *P* the compressor or pump for increasing the pressure of the gasified ammonia, *C* the condenser for cooling and liquefying the gasified ammonia, and *V* a throttling valve by which the flow of liquefied ammonia under condenser pressure is controlled as it passes from the receiver *R* to the expansion coil *E*, in which a materially lower pressure is maintained by the pump in order that the refrigerating medium may boil at a sufficiently low temperature to absorb heat from, and consequently refrigerate, the surrounding air which is already cold. In practice the systems are somewhat more elaborate.

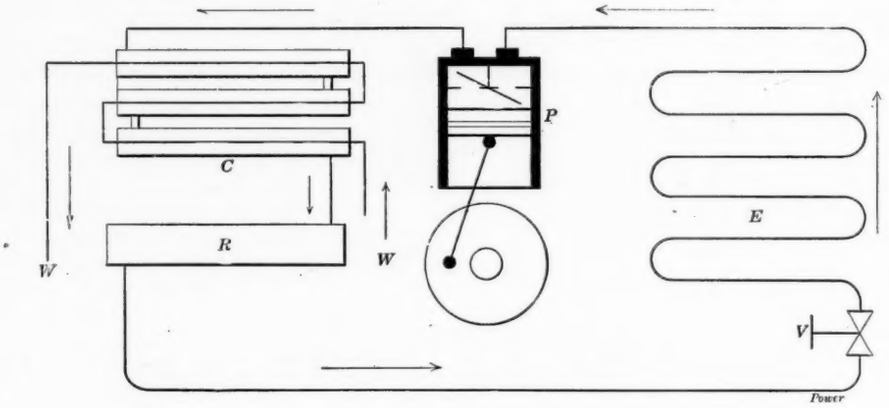


FIG. 1. ESSENTIAL MEMBERS OF COMPRESSION SYSTEM

In order that some work of refrigeration may be carried on while the plant proper is shut down either in case of accident or in order to avoid the expense of skilled attendance during a part of the twenty-four hours, the brine-circulating system is employed. Such a system is represented in the conventionalized diagram, Fig. 2. In addition to the usual members of the direct-expansion refrigerating system represented in Fig. 1, the brine system employs a brine tank *T*, Fig. 2, a series of air-cooling or brine coils and a brine pump *B B*. In this case the initial cooling effect of the evaporating ammonia is expended in the brine which is circulated by the brine pump through the air-cooling coils installed in the cold-storage room *R*.

Salt, either sodium chloride (NaCl) or calcium chloride (CaCl) is required for making the brine, and suitable insulation must be provided for the brine tank, the brine cylinders of the pump and all brine piping outside of the cold-storage compartments in order to reduce to a minimum the losses due to the radiation of cold, or more accurately speaking, the absorption of heat. In addition to the first cost of the previously mentioned items the operating expense of power required to operate the brine pump must be considered; first, for the actual transfer of brine from the brine tank through the cooling coils back to the tank; second, to overcome the friction of the brine in traversing the above cycle; third, to produce sufficient additional refrigeration to make up for the heating effect produced mechanically by the circulation of brine and the heat actually absorbed through the brine tank and brine-piping insulation; and fourth, to make up for the greatly reduced efficiency occasioned by the necessity of operating the refrigerating plant proper at a materially lower back pressure in order to produce a sufficiently lower ammonia temperature to make up for the second heat transfer encountered between the atmosphere of the cold-storage compartments and the ammonia gas. The increased operating expense directly resulting from the inherent low efficiency of the brine system is sometimes as high as 25 per cent., and isolated instances have been noted in small plants where the cost of circulating the brine alone was almost as great as that of cooling it.

Instead of the brine system some builders employ what is known as the "congealing-tank" system, represented diagrammatically in Fig. 3. The first cost of the brine pump and the power required to operate it, and the cost of brine pipe and tank insulation, as well as the losses through the same, are avoided in this system by virtually splitting up the main brine tank and installing the pieces commonly called "congealing tanks" in the several cold-storage compartments. In this case the heat-absorbing surface of the several smaller tanks entirely replaces that of the brine coils. Here, however, the desirability from a mechanical standpoint of making the tanks as small as possible debars the carrying of sufficiently large volumes of brine to provide for refrigerating the rooms for any great length of time, by the rise in temperature of the brine. This involves only the specific heat of the brine, the amount of refrigeration produced being the product of the pounds of brine, the number of degrees rise in temperature and the specific heat of the brine.

$$B.t.u. = lb.\ brine \times (t - t_1) \times specific\ heat\ of\ brine.$$

In order to store more refrigeration in the comparatively small volume of the

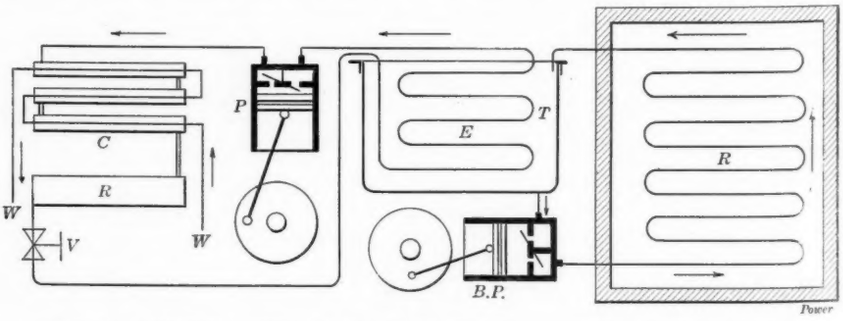


FIG. 2. AMMONIA SYSTEM MAY BE SHUT DOWN AND BRINE CIRCULATED

congealing tanks a weak solution of brine is employed, which, in freezing, stores refrigeration proportional to the number of pounds of brine frozen multiplied by the latent heat of fusion of the brine ice plus the cold required to chill the brine down to the freezing point.

This expression does not provide for the small additional amount of refrigeration required to cool the brine ice below its freezing point. When the temperature of the ice is below the freezing point the additional refrigeration will be found from the expression

$$lb.\ ice \times specific\ heat\ of\ the\ ice \times (t_1 - t_2).$$

In the above expressions t is the temperature of the brine before cooling, t_1 the temperature at which the brine freezes and t_2 the temperature to which the ice is cooled after freezing.

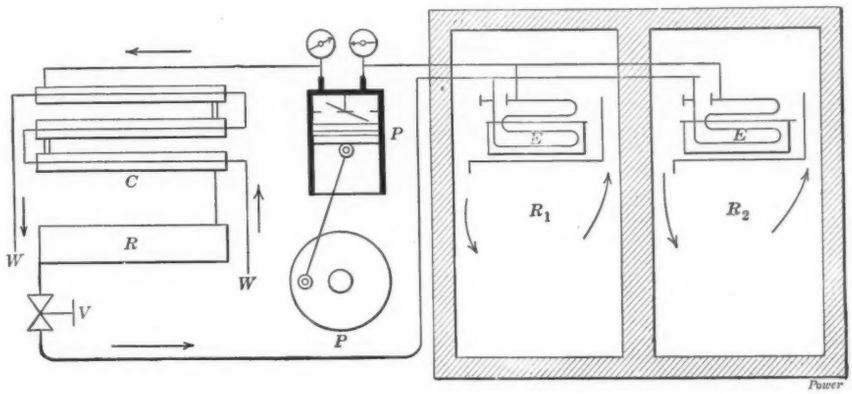


FIG. 3. CONGEALING-TANK BRINE SYSTEM

In order that the rooms may be cooled more quickly when the refrigerating plant resumes operation after several hours of inaction, it is often customary to install from one-third to two-thirds of the total expansion piping outside the tanks in direct contact with the atmosphere of the rooms, the remaining two-thirds or one-third being submerged in the weak brine of the congealing tanks which have been substituted to take the place of one large brine tank.

It is evident from the foregoing that so far as decreased efficiency entailed by the double-heat interchange of the brine-circulating system is concerned, the congealing-tank system is only a compromise. While a part of the piping cools the air by direct radiation, the greater part must transmit cold first to the surrounding brine, or ice, as the case may be, which medium in turn must transmit it on through the walls of the tanks to the air; and a sufficiently low ammonia evaporation or "back pressure" with its entailed loss of efficiency, must be maintained in both the submerged and the exposed coils, to carry out the double-heat interchange in the former. The fact that the refrigeration stored up during the hours of operation of the plant for use during the hours of rest is in the form of a coating of ice on the coils instead of brine kept in constant circulation, further increases the necessity for a lower back pressure; first, because ice is a poorer conductor of heat than brine; second, because the congealing-tank surface as well as that of the expansion pipes, is often insulated with ice; and third, because the stagnant brine, or, what is even worse, ice in the case of the congealing-tank system, absorbs and gives up heat less readily than the moving brine.

As it is mechanically impracticable to make the thin, light congealing tanks indefinitely continuous, as is done in the case of ammonia or brine-cooling coils, the ammonia-expansion coils installed in such tanks must be made shorter. This necessitates the use of an increased number of return bends or fittings for the installation of the system as a whole and accordingly tends to increase the initial cost of the expansion piping for both material and labor.

While local conditions must be the deciding factors in every case, congealing-tank systems of small capacity usually compare quite favorably with the brine-circulation systems of similar capacities; but it must be remembered that both systems have the disadvantage of being inherently inefficient because of the necessity of operating under lower back pressures in order to produce the correspondingly lower temperatures required to effect the double-heat transfer. At the lower pressures fewer pounds of the refrigerating medium are passed through the compressor per cubic foot of piston displacement and a greater number of pounds are necessary to produce a given refrigerating effect, both of which conditions make it necessary to speed up or otherwise increase the displacement of the compressor in order to produce the same amount of cooling duty.

By the direct expansion of the refrigerant, cold is produced just where it is required and more nearly at the temperatures required, and incidentally, aside from the saving in power required to operate the compressor and to pump the brine, a saving in investment for a suitable room and foundations for brine tanks and pumps as well as for the tanks and pumps themselves, necessary piping and insulation, etc. Thermal losses due to radiation through the insulation of these members and through that due to the heating affect of pumping the brine are entirely eliminated.

The type of system best adapted to a given set of requirements can be determined only after carefully considering the relative importance of such factors as cost of power, cost of attendance, allowable temperature variation, availability of capital and probable earning power of plant.

While the use of electric power undoubtedly reduces the duties of the attendant, safety and the necessity of adjusting hand-expansion valves require more or less constant attention, and the slight additional attention required by the steam or combustion engine is usually too slight to make up for the usual comparatively high cost of electric power.

The application of reliable safety devices, however, which protect the plant in case of abnormal pressure resulting from failure of water supply or the accidental closing of the wrong valves, together with a reliable automatic expansion valve, eliminates these two most important duties of the attendant. When the compressors are of the inclosed-crank self-oiling type, and electric motors are employed, very little attention need be paid to lubrication, and the item of attendance becomes very small indeed.

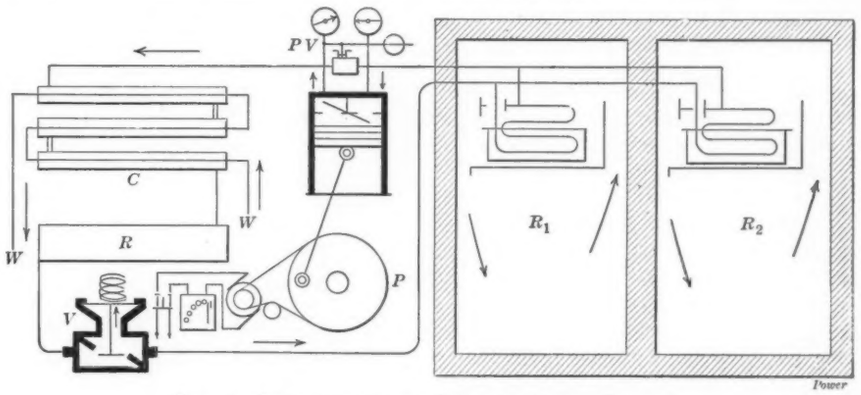


FIG. 4. SEMI-AUTOMATIC REFRIGERATING SYSTEM

The semi-automatic system usually employed to meet such conditions is illustrated diagrammatically in Fig. 4. It will be noted that this system is essentially the same as the congealing-tank system illustrated in Fig. 3, except for the addi-

tion of an automatic expansion valve *V* and some suitable safety device *P V* for preventing the occurrence of abnormal pressures. In the case of other than electrical power, this may be a simple mechanical device, such as a spring or a weight-loaded "pop" valve between the high-pressure and the low-pressure sides of the system. In the case of electric power a device actuated by pressure such as is shown diagrammatically in Fig. 5, may be employed. Such a device consists essentially of either a Bourdon tube or a diaphragm *D* arranged to move a lever arm *A* in such a way as either to disengage a latch holding a spring-opening electric switch closed or, where there is a no-voltage release coil in the motor-controlling circuit, the device may be arranged as at *P D*, Fig. 6. Here the diaphragm *D* bowing outward under abnormal pressure *P* is employed simply to make an electric contact *C* for short-circuiting a no-voltage coil which, being thereby deënergized, allows a spring to open the motor circuit and interrupt the operation of the refrigerating system, just as would occur in case of failure of line voltage. It is almost unnecessary to add that a thermostat *T* may be similarly employed to stop the refrigerating machine when the desired temperature has been produced in the cold-storage compartments.

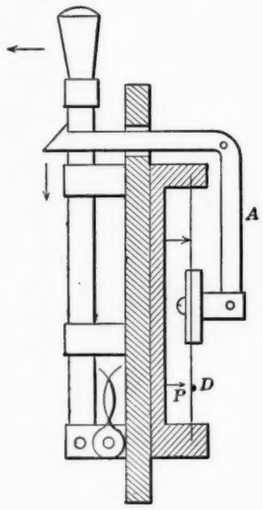


FIG. 5.

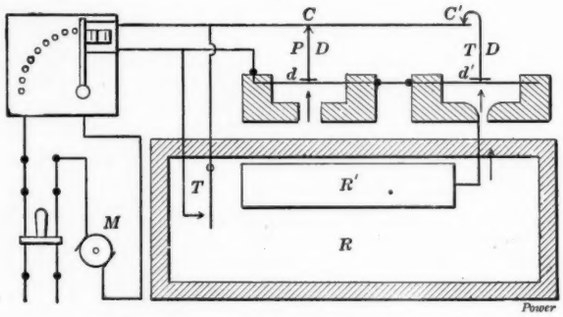


FIG. 6. THERMOSTATIC MOTOR CONTROL

In the case of a spring-opening switch an outside source of power, such as a storage battery, would have to be used in connection with the thermostat to supply sufficient power to operate the latch, or instead of the laminated-blade form of thermostat illustrated in Fig. 5 a thermostatic device *T D*, Fig. 6, actuated by the expansion force of a gas under pressure may be employed. In this case a small amount of some volatile liquid, such as anhydrous ammonia, is placed in a small closed receiver *R'* and connected to the thermostatic device *T D* by a small tube. A decrease in the temperature of the cold-storage compartment *R* causes a corresponding decrease in pressure in the receiver *R'* and beneath the diaphragm *d*, which allows it to return to its normal flat position where it effects the making of an electrical contact at *c* which stops the machine.

Still more elaborate systems have been devised to the end of eliminating all attendance. Such "completely automatic" systems divide themselves into two classes according to the two possible cycles of cause and effect on which the systems may be operated. In the former systems, illustrated diagrammatically in Fig. 7, variations in temperature in the cold-storage room *R* effect the starting and stopping of the refrigerating machine, which through the resulting variations in back pressure effects the regulation of the flow of refrigerant to the expansion coils and through the resulting variations in head pressure effects the regulation of the flow of water on the condenser coils.

In the latter systems, illustrated diagrammatically in Fig. 8, variations in temperature in the cold-storage room *R*, instead of effecting the starting and stopping of the refrigerating machine, and indirectly the regulation of the flow of the refrigerating medium, in this case directly controls the flow of the refrigerant through a thermostatic-expansion valve *V* which in turn controls the starting and stopping of the machine through the resulting pressures. The cycle of operation of each system is given in detail in the following.

The thermostatically controlled system shown in Fig. 7 employs a laminated-blade or other reliable type of thermostat for making and breaking two electric circuits which, without going into full detail regarding the complete circuit, stops and starts the machine through the operation of an appropriate automatic motor-controlling panel. The electrical solenoid switch *S*, when energized, raises the motor-controller arm slowly over the rheostat segments. The deënergizing of this solenoid by short-circuiting when the thermostat makes the circuit through the stopping contact, allows the rheostat arm to drop, open circuiting and stopping the motor.

The operation of the machine is to draw the refrigerant vapor from the expansion coils *E* and discharge it into the condenser *C*, which operation reduces the pressure in the condenser coils. The reduction in pressure in the expansion or low-pressure side of the system allows a properly adjusted spring *s* or weight on the expansion valve *V* to overcome the back pressure of the gas exerted beneath the diaphragm *d*, which forces the attached valve stem down, opens the valve and allows the refrigerant to flow from the liquid receiver *R* to the expansion coils. In a similar manner the increased head or condenser pressure operates on a water-controlling valve *W V*, which instead of closing with increasing pressure, opens and admits cooling water to the condenser *C*.

The evaporation of the liquid refrigerant admitted to the expansion coils by the expansion valve produces an increase in pressure which overcomes the pressure of the spring above the diaphragm and closes the valve until the pressure is so reduced by the drawing away of the vapors by the compressor that the spring again overcomes the pressure of the gas below the diaphragm, when the valve opens and more liquid is allowed to pass. As a matter of fact there is no appreciable variation in back pressure and accordingly no intermittence in the feed of the liquid. The valve acts simply as a pressure-reducing valve maintaining that back pressure for which it is adjusted until the machine stops, when the evaporation of the residual liquid in the expansion coils produces an abnormal rise in back pressure which

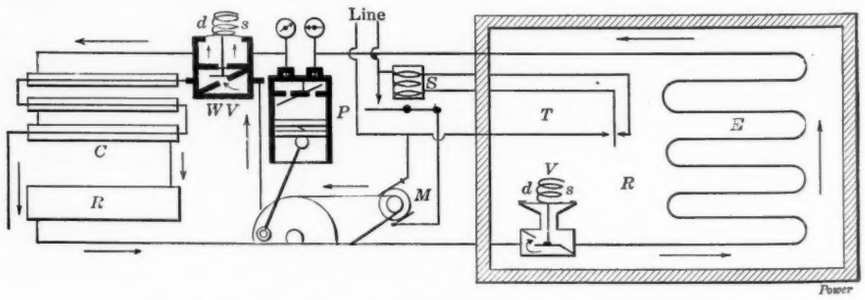


FIG. 7. COMPLETELY AUTOMATIC REFRIGERATING SYSTEM

overcomes the tension of the spring and tightly closes the valve.

When the machine is stopped and no more hot, high-pressure gas is discharged into the condenser, the cooling water soon reduces the temperature and corresponding pressure in the high-pressure side of the system, which allows the spring in the water valve *W V* to overcome this reduced pressure and close the valve, interrupting the flow of water to the condenser.

In the second method of control, illustrated in Fig. 8, an increase in temperature causes the thermostatic fluid in the thermostatic tube *T* to expand and exert an increased pressure under the diaphragm *d* of the thermostatic expansion valve *V*, overcoming the adjusting spring *s*, opening the valve and admitting liquid refrigerant to the expansion coils. This increase in expansion-coil pressure caused by the introduction of the liquid overcomes the pressure of the spring *s* above the diaphragm *d* of the pressure-actuated, motor-controlling device *M C* making the electric circuit to the motor and starting the machine. The resulting decrease in back pressure allows the spring of the expansion valve to assert itself, forcing the diaphragm down and throttling the incoming liquid to the requirements of the compartment. When the temperature has been sufficiently reduced, the correspondingly reduced pressure in the thermostatic tube *T* allows the spring *s* to close the thermostatic expansion valve *V* and the reducing pressure in the expansion coils is now overcome by the spring in the motor-controlling device *M C*, which, operating in the opposite direction due to the decreased pressure, stops the motor.

The automatic water valve shown in Fig. 8 operates on the same principle as that described in Fig. 7. In the semi-automatic systems illustrated diagrammatically in Figs. 5 and 6, as well as in the completely automatic systems, Figs. 7 and 8, electric power is employed. Small systems may be satisfactorily operated semi-automatically at the expense of somewhat more attendance, and usually a considerable saving in cost of power is effected by the substitution of some efficient type of combustion engine. The advisability of such a substitution at the present day of an unquestionably reliable combustion engine depends almost entirely on the relative local cost of attendance, and of power developed by electricity, illuminating gas, gasolene, kerosene, fuel oil or producer gas.

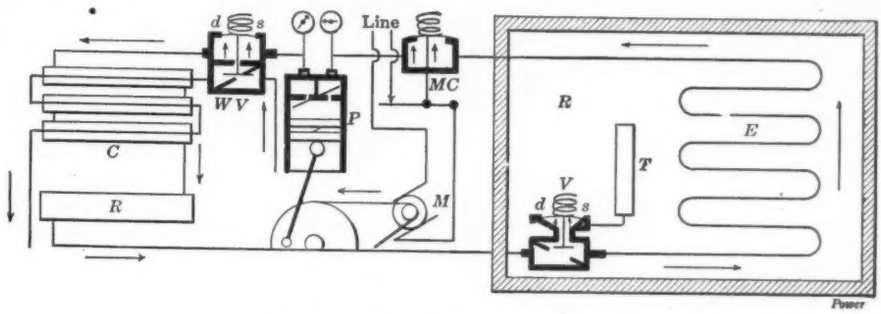
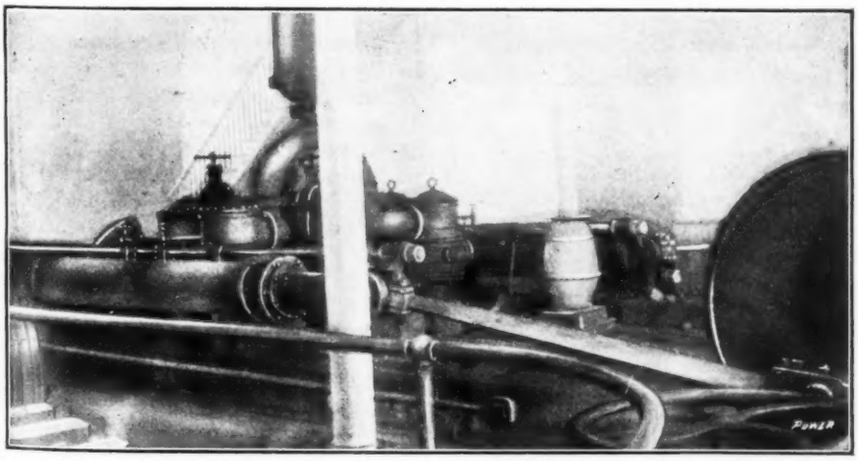


FIG. 8. SYSTEM CONTROLLED BY THERMOSTATIC EXPANSION VALVE

Old Water Works Pump at Lynchburg

When visiting the city of Lynchburg, Va., it is an interesting diversion to view the old city pumping station located on the banks of the James river. This old plant did faithful work up to within a few years, when it gave way to a more modern system.



OLD WATER-WORKS PUMP

Four waterwheel-driven pumps and one steam pump comprise the present installation. One of these old timers is illustrated herewith. It was installed in 1882, or 28 years ago, by a local firm, and is driven by a 56-inch water-turbine wheel. The water is obtained from a raceway which branches off at a dam some distance above the pumping station.

This duplex pump consists of four 15½-inch cast-iron cylinders, each made with a flange on both ends. Two of these cylinders are bolted end to end on each side of the pump with a blank plate placed between each pair. This plate forms a central cylinder head for the two cylinders. The two outer ends of the cylinder are fitted with stuffing boxes, and each cylinder is fitted with a 10½-inch plunger with a 36-inch stroke. The two crank-end plungers obtain motion from a crank rod on each side, as shown. The crosshead slides in a flat guide, the sides of which are beveled inward at the top to prevent the crosshead from tipping.

The head-end plungers are driven by two side rods which extend from the crosshead on the crank-end plunger to that of the head-end plunger. The crosshead guides of the head-end plunger is the same as that on the crank end of the pump. The cylinders are each connected to a valve pot, or chamber, which contains a discharge and suction-valve seat deck, each deck containing nineteen valves. The suction pipe is 12 inches, and the discharge pipe 14 inches in diameter. An air chamber is located on the arched pipe, shown between the water cylinders.

The two crank pins are set 90 degrees apart, both crank disks being hung on the same crank shaft. Near the center of the shaft is a beveled gear which meshes with a smaller beveled gear keyed to the waterwheel shaft. The average lift of the pump is 5 feet, and the pressure pumped against is 156 pounds per square inch. The pump runs at a speed of 18 revolutions per minute.

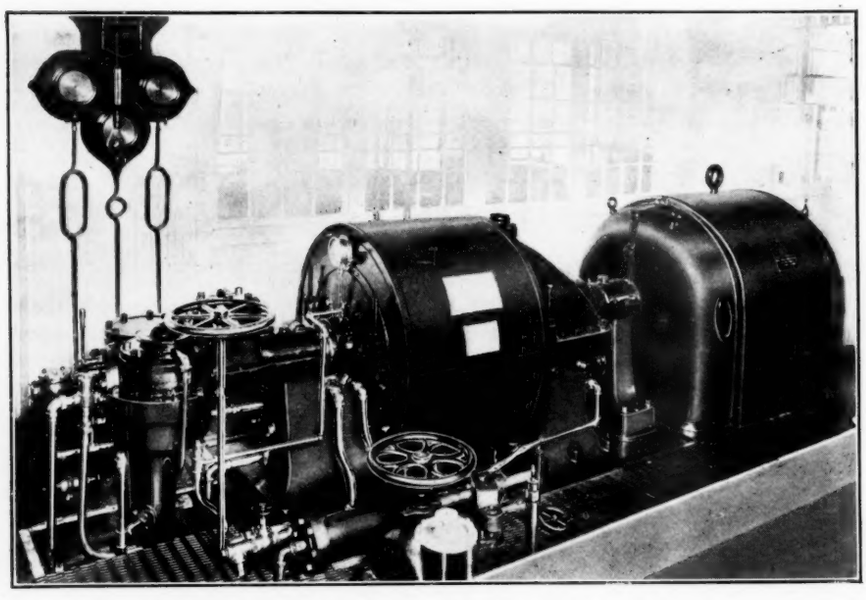
Electrical Department

Use of Synchronous Electrical Machines to Connect Low Pressure Turbines and Reciprocating Engines

By Charles B. Cooke, Jr.

Especially conducted to be of interest and service to the men in charge of the electrical equipment.

The low-pressure turbine has greatly facilitated the extension of existing power plants with minimum increase in floor area and complementary equipment. An interesting problem in this connection developed with the recent addition of a Westinghouse low-pressure turbine to the Bernon Mills power plant in Georgiaville, R. I. Previous to the enlargement of the power equipment, the steam plant of this company included one 23x60 twin-cylinder Corliss engine which developed approximately 420 indicated horsepower under normal operating conditions. The engine is belted directly to a line shaft and carries a characteristic mill load.



Low-pressure Turbine and Synchronous Generator

With additional power requirements, however, it was found necessary nearly to double the steam-plant output, and, moreover, it was essential that this should be accomplished without any material extension of the station limits. To fulfil these demands it was finally decided to operate a low-pressure turbine with the exhaust steam of the reciprocating engine, the turbine to drive an alternating-current generator electrically interlocked with a synchronous motor coupled to the line shaft. Excitation for both the generator and motor is furnished by a small direct-current dynamo belt driven from the synchronous motor.

While in many cases the induction motor is given preference over the synchronous type, chiefly because of its large starting torque, which makes it unnecessary to use auxiliary starting apparatus, the conditions at the Bernon Mills made this qualification unnecessary, the motor being brought to speed by the Corliss engine.

The capacity of the low-pressure unit was determined from the full-load steam consumption of the engine, 12,400 pounds per hour, and by assuming for the turbine a steam rate of 36 pounds per kilowatt-hour, an allowance of 7 per cent. being made for moisture in the engine exhaust. This method gave an available turbine-generator power of 320 kilowatts and accordingly a low-pressure turbine normally rated at 300 kilowatts was installed. This turbine is of the standard Westinghouse single-flow construction, operating between 15 pounds absolute pressure and 28 inches vacuum, and is operated in conjunction with a barometric condenser.

The unusual character of this installation necessarily involves an interesting procedure on starting up. The reciprocating engine is first started slowly, exhausting to the barometric condenser. The available natural head of 28 feet existing at the plant being insufficient for priming purposes, a slight vacuum of 5 to 6 inches is first produced by bypassing part of the condensing water to the tail pipe of the barometric tube. Through the medium of this partial vacuum, the turbine is started by closing a valve which, when open, bypasses the steam from the engine to the condenser, the turbine inlet pressure increasing to about 5 pounds gage and remaining about at that point until a vacuum of 12 to 15 inches is formed by the condensation of steam through the agency of tail-pipe injection. The valve which passes the injection water to the tail pipe is then closed, and the 15-inch vacuum elevates the condensing medium to the condenser head, readily establishing the working vacuum of 28 inches or over.

The synchronous motor coupled to the line shaft having been brought up to speed by the engine, its field and that of the generator are excited, following which the voltage of both machines is raised to 400 volts, the machines are synchronized, and finally thrown in parallel.

This procedure, while necessitating several steps, has proved very simple to the operators, the entire operation from starting the reciprocating engine to placing the station under full load rarely consuming more than five minutes.

The electrical principles involved in this method of power development render the provision of a turbine governor unnecessary, because when the generator and motor have been put in parallel, the interlocking or synchronizing force developed when either machine tries to depart from synchronism effectually prevents any variation in the speed of the turbine. If, for instance, the motor tends to increase its speed, the engine will be partly relieved of its load and the steam consumption consequently reduced. Then, with less steam passing to the turbine, its speed and output decrease, causing a similar reduction of speed in the motor, until a balanced condition is again obtained. This action follows any change in the rate of work in the main unit with but very small lag.

The electrical equilibrium of the system is further maintained by the employment of a synchronous motor of larger capacity than the turbine, this being, in effect, the electrical analogue of the flywheel on an engine.

If, for any reason, less power is required from the shaft, the engine and motor share the decrease in the demand, the former through the action of its governor and the latter by reason of its phase relation with the generator.

A New Alternator

In building large alternating-current generators, of course, the features of regulation and wave form receive full consideration along with the more familiar features of efficiency, temperature rise,

FIG. 1. THE "IDEAL" ARMATURE

etc., but purchasers of small generators of this class are usually contented if the machines run reliably and do not overheat; consequently, many (not all) small alternators are built without a great deal of consideration for the finer details of performance, such as wave form, behavior under different power factors, etc. The conditions of use, however, have steadily changed in such directions as to necessitate more attention to the points mentioned, and in response to this development many builders of small alternators are now giving relatively as much effort to the perfection of the hitherto neglected features as is bestowed upon the same features by designers of large machines.

Amongst the small alternators designed on "large" lines is the "Ideal" machine illustrated herewith. As Fig. 1 indicates,

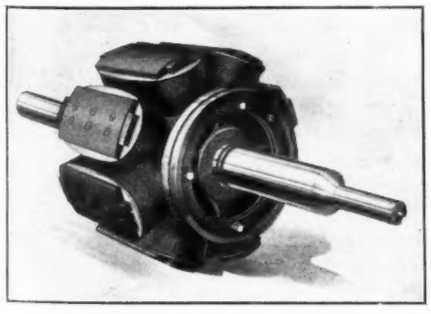


FIG. 2. FIELD MAGNET

the armature is the stationary member. The core is mounted in a one-piece housing of cast iron and is held in place by clamps at the ends, to avoid the eddy-current difficulties entailed by the use of bolts through the core. Ventilating ducts are left at intervals along the core and the "spacer" in each duct is made with fins which bear against the core teeth on each side of the duct, to prevent vibration of the teeth and resultant humming. The coils are form-wound and individually insulated, the slots being of the entirely open form which permits the direct insertion of a taped coil.

The field magnet is a steel casting with solid shoes bolted on the ends of the magnet cores. The object of using solid instead of laminated shoes is to facilitate parallel operation by supplying a path for the eddy currents set up by hunting and irregularities in angular velocity, without the use of squirrel-cage or other forms of dampers. The air-gap length and the slot width are proportioned with a view to restricting the pole-face losses to satisfactory values during normal operation, the aim being that excessive eddy currents shall be induced only by variations in angular velocity which are serious enough to jeopardize parallel operation; such eddy currents exert, of course, a synchronizing influence, opposing any tendency to fall or pull out of step. Fig. 2 illustrates the construction of the field magnet. The magnet coils are composed of square wire in smaller

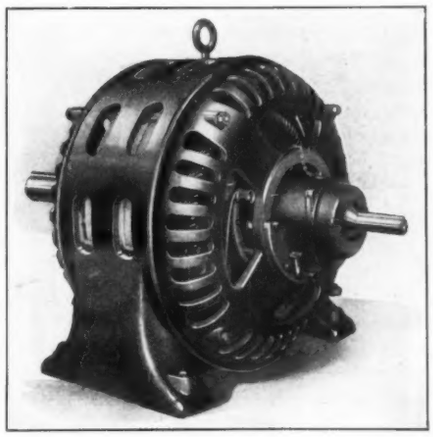


FIG. 3. COMPLETE MACHINE

sizes and thin copper "ribbon" wound on edge in larger sizes. The "space factor," therefore, is obviously about 30 per cent. higher than could be obtained with round wire, and the coil is mechanically more sturdy. The pole shoes are shaped with a view to producing a true sine wave of electromotive force under average operating conditions—that is, at or near full load and with a power factor between 80 per cent. and unity. Of course, a true sine wave cannot be obtained at all loads and power factors, and the next best course is to get it under predominating conditions. The same argument holds as to efficiency, and instead of yielding maximum efficiency at full load, the "Ideal" alternate is designed for greatest efficiency at around 80 or 90 per cent. of full load, which, in everyday work, is carried a much longer proportion of the running time than full load, as a general rule.

Fig. 3 shows the appearance of the complete machine, and close inspection will enable the reader to see that a split journal box is used and that the lower half of it is bolted to a circular seat on the end bracket of the machine. The object in using this construction is to make it easy to remove the journal box or to take out the field magnet. The pulley of a belted alternator need not be removed in order to do either of these things, and the journal box of a direct-coupled machine can be removed without taking down the shaft.

These alternators are built in sizes ranging from 20 to 200 kilovolt-amperes by the Ideal Electric and Manufacturing Company, Mansfield, Ohio.

LETTERS

Handling a Large Motor Starter

The following plan was used to prevent arcing on a heavy-duty starting box which is used for starting a large motor and is not equipped with magnetic blow-out:

A piece of wood about 2 inches wide and a foot long was whittled down to a chisel edge. When ready to start the motor, this was inserted between the first and second contact blocks, and the sliding contact pulled over against it. When the motor had come up to speed on this contact the stick was put between the second and third notches and the sliding contact again moved over, repeating this process until the last two or three blocks were reached, after which it was unnecessary.

The reason for using the wooden wedge was that the sliding friction of the brush makes it difficult to move the lever of a large starter just far enough to get full bearing surface on a given contact plate and to avoid overrunning the contact and forming an arc with the next plate.

The idea originated, I believe, with C. C. Constantine, of the Baltimore Copper Works.

DONALD M. LIDDELL.

Grasselli, Ind.

Wanted: An Automatic Water Rheostat for a Pump Motor

A triplex pump, 9x12 inches, is to be placed underground and driven by a 220-volt shunt-wound motor of 50 horsepower, running at 970 revolutions per minute. This pump will draw water from a sump supplied by sinking pumps and from other sources, and the flow will be variable, up to its maximum capacity. It is desired to vary the speed of the motor automatically as the water in the sump rises and falls, the motor speed and pump work increasing with the

rise in water level and decreasing with the fall. It is desired that the pump continue running, even at lowest water level.

There appear to be many self-starters on the market; but it is desired to construct a water starter which, by closing the gap as water level rises and opening it as water falls, will vary the motor-circuit resistance and alter the motor speed. The usual form of starting box will be used, the water resistance being connected between the starting box and the motor.

The principal difficulty seems to be to proportion the resistance of the water rheostat so that it will not be too large at low level and stop the motor. I should be glad to see diagrams of arrangements suggested by other readers. The water rheostat should short-circuit itself at the high point. The mine water contains so much acid that it would probably not be necessary to add any chemical, and there could be a steady flow through the rheostat.

W. H. EARLE.

Ocampo, Chihuahua, Mexico.

Charging Storage Batteries in Parallel

On page 1426, of the issue of August 9, Mr. Meade gives some diagrams of switchboard wiring for series or parallel charging of storage batteries, which are open to criticism. As a rule, small isolated plants are 110-volt installations and in all probability a battery in such a plant would have to be charged in parallel. Mr. Meade's diagrams show a main-line rheostat only. Theoretically, this arrangement would work, but practically it would seldom if ever give any degree of satisfaction if equal charging of the two sections is to be considered. Anyone who has ever tried to charge a battery in parallel sections without a separate rheostat in each section has realized that it is impossible to balance the charging current. A person who installed a battery according to the diagrams of Mr. Meade's article, if unfamiliar with that class of work, would have trouble on his hands.

The addition of the balancing rheostats would not complicate the wiring and certainly would aid in the successful operation of the battery. The increased life of the battery due to regular charging would offset the additional cost of the balancing rheostat many times over.

It would be preferable to leave out the main-line rheostat and install two balancing rheostats rather than use a main-line rheostat only, the latter being decidedly bad practice to advocate for a piece of apparatus, the cost of which would be a large part of the total cost of a small installation, and of comparatively short life, even with the best of care.

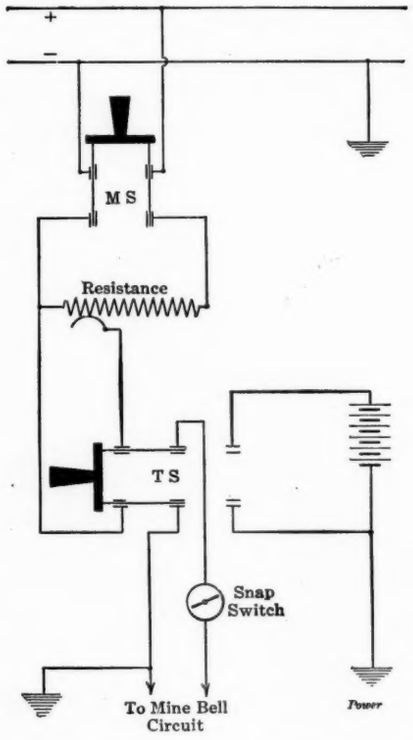
A. C. KERR.

Ft. Monroe, Va.

Operating Bells in Mines

Signal bells around a mine are as necessary as water in the boilers, and the quantity of dry batteries ordinarily used up makes a considerable expense item in the course of a year. As all our signal bells are of large size the current consumption from batteries was necessarily large, and a battery of six and eight cells would not last very long.

To avoid using batteries except when the power plant was shut down (which is very seldom) the circuit arrangement shown by the accompanying diagram was installed. It has not given one particle of trouble, and the cells will last until



SUPPLY CONNECTIONS FOR MINE BELLS

they lose their strength through age. It is advisable to ground one side of the bell circuit because the negative side of the power circuit is grounded for trolley return in the mine. There is a sliding contact on the resistance by means of which the voltage on the bell lines can be raised when the lines become leaky or poor connections are made. The snap switch is included in the circuit to cut out the bells in case of a short-circuit on the lines.

All circuits for bells are taken from the double-pole double-throw transfer switch, *T S*. The main switch *M S* is provided to cut the whole equipment off from the power circuit if it should become necessary, as in case of trouble in the resistance.

L. EARLE BROWN.

Roundup, Mont.

Unusual Cause of a Dead Dynamo

Some time ago a small shunt-wound direct-current generator used for excitation purposes gave trouble. While in service the machine let down, failing to generate any voltage whatever. Since trouble of this kind had been encountered before, we tried the usual means of correction. Previously the trouble was due to an insulating coating on the commutator, of particles from a number of buffing wheels located nearby. After sandpapering both the commutator and the brushes, the machine built up again, but generated for only a short time, when it again refused to work. A superficial examination failed to throw any light on the trouble, and we settled down to test. After testing all the lines and finding no trouble, we tested the field winding and found that it seemed to be all right. We were then at a loss, because the machine acted exactly as an open field circuit would make it do. Having another machine running, I connected the field circuit of the "dead" machine to the busbars of the operating machine, through the rheostat of the first machine. The machine built up nicely, but upon careful examination we noticed a small arc at the bottom of one of the field-magnet coils of the affected machine.

Upon dismantling the machine and examining the coil we found that in winding the coil a layer of insulation was put around it before the final layer of wire was wound on, and along a heavy strip of insulation was laid a strip of german silver about 1 inch wide and 1/32 inch thick. The top of this had been carefully insulated to within ¾ of an inch of the lower end. The last layer of wire was then wound on beginning at the top of the strip and running to the lower end. As the final convolutions came to the bare surface of the german-silver strip, the insulation was scraped off and the last six turns were soldered, as the assembler supposed, to the german-silver strip, but the solder failed to "run" and only the surfaces of the wires had been joined with solder. The only connection to the strip was the contact due to the tension of the wire wound on the bare end of the strip. The strip was used to carry the current to the other end of the coil, for convenience in connecting. Expansion and contraction of the strip caused the machine to fail at one time and work at another. When cool, the contraction would make a good joint, thus enabling the operator to start the machine. This was also the reason why all of the tests failed to locate the trouble.

When the excitation was effected from the duplicate machine, the poor contact due to expansion caused the arcing at the defective point.

C. A. DAVIES.

Cincinnati, O.

Gas Power Department

Generation of Power from Peat*

By T. Arthur Mighill

There is as yet, to my knowledge, no plant in operation where peat fuel is handled entirely by machinery from start to finish. I believe that digging the peat, moving pallets, or gathering dried peat by hand is impractical if peat fuel is to be prepared cheaply enough to compete with coal. Although some processes have eliminated most of the hand labor, there is much yet to be done. We hear of successful peat-power plants in Europe; however, in America we are not able to operate under European conditions. We must pay male laborers higher wages than prevail in Europe, and we do not employ women and children for such work.

As peat is a fuel of low calorific value, averaging from 6000 to 9000 B.t.u. per pound of dry substance, one pound of good coal is equal to one and one-half to two pounds of average peat. Although peat when burned under a boiler will generate steam, the quantity required is nearly twice that of coal, so that a larger grate area is required and the fuel must be more frequently fired. The ashes are light and can easily be removed. The flame is long and should put the heat where it will do the most good, in the tubes. From its light and pulverent nature, when the draft is forced, considerable fuel might find its way into the stack before complete combustion.

For small plants it may not be practical or desirable to use a gas producer and engine on account of the simplicity of operation of a steam boiler and engine. I am advocating the use of the gas producer and engine in large plants not on account of any difficulty in using peat as a steam-boiler fuel but on account of the higher heat efficiency of the gas engine.

In contemplating the use of peat as a source of power we must consider the economic conditions connected with the locality. We must consider the price of coal at the locality and the cost of preparing peat fuel. The farther the bog is from the coalfields the greater the possibilities of the peat proposition. The matter ends here if the power is to be used for factory purposes, but if electrical energy is to be sold, consideration must be given to the situation of the bog relative to the community to be served. As electricity can easily be transmitted over a considerable distance, the bog may be some distance from the region served, but the generating plant must be at the bog. Freight charges must be eliminated.

Everything worth while in the gas engine and producer industry will be treated here in a way that can be of use to practical men.

The preparation of peat for use as fuel consists of digging the peat, drying it and storing it. The gasification of it is the most important process of the series. I have made considerable inquiry as to whether peat will clinker badly in a producer but have received no satisfactory answer. In a series of experiments at Pittsburg I found some clinkers, but I cannot say that they were any worse than those formed by coal. From the fineness of the ash I judge that the possibilities of forming a large amount of clinker are not very great. However, if the peat is too finely divided the draft will form holes and here the combustion will be most intense, favoring clinker formation. The lightness and porosity of peat is a drawback, for the combustion may be so rapid in places that holes or "chimneys" are formed. This necessitates considerable poking of the fire; and every poke of the iron is likely to make a path for the air. The lightness of the fuel and the low heat value greatly increase the size of the peat producer over a coal-gas producer of the same power capacity.

Proportion of Moisture

The content of water in air-dried peat makes the operation of a producer uncertain, for to my mind there is quite a difference between running steam through incandescent coke, as in an anthracite producer, and using the steam liberated in the fuel bed itself at a rate which, from the nature of the operation, must be irregular. Under such conditions the producer may run sometimes too hot and sometimes too cool and the heat value of the gas may vary greatly.

This raises the question, how much water can peat contain and be used successfully in a producer? This can be determined only by long tests of fuels containing various quantities of water, not by such short runs of which accounts are available. It has been said that peat containing as much as 50 per cent. of moisture can be used in a producer. If this were true it would cut down the drying expense very much, but I believe that 30 to 35 per cent. of moisture is about the limit that can be allowed.

The evaporation of water in a producer only to have it condense again unaltered is inexcusable unless we are going to recover ammonia, as in the Mond process, or else find some compensation in the preparation of the fuel whereby the producer is worked extra to save the drying field. It has been shown that to attempt to recover byproducts, except in plants of about 3000 horsepower and over, is impracticable.

If the temperature of the producer gets too low, as through the evaporation of too much water, the carbonic acid is not decomposed and the heat value of the gas is correspondingly lowered.

Preparation of Fuel

The form in which the fuel is applied is of great importance. There are records of runs in this country where machine peat and briquetted peat were used. There should be no trouble in using briquets but I believe that the expense of manufacturing them does not warrant their use, and I consider properly machined peat just as good. I am not a believer, however, in the idea that a producer can be run on anything that is combustible.

In a run of about two weeks, at Pittsburg, it was found that peat dug out of the bog and not machined but thrown on the ground to dry did not make a fuel suitable for producer purposes. We did not dig the peat out in blocks as is sometimes done in Europe, but dumped a car load of fresh peat on the ground and spread it out to a thickness of several inches. The dried peat was shipped by rail from Massachusetts to Pittsburg. In all, it was shoveled over about ten times before it was burned in the producer. The result was that there was so large a percentage of "fines" in it that the draft through the producer was greatly restricted, and the suction rose so high that the operation of the producer became a source of danger. As a result, we got poor gas, high in carbonic acid.

To operate a producer successfully on peat the fuel must be prepared by machining it and drying it so that it hardens into lumps and does not produce much "fines" when handled.

*Abstract of a paper read before the American Peat Society, at Ottawa.

Resources Required for the Continuous Development of 1000 Horsepower

Reports of producer tests show a consumption of from 1½ to 2½ pounds of dry peat per horsepower-hour. Suppose the average is two pounds, containing, say, 9000 B.t.u. per pound, which would represent an excellent quality of peat. As it is impractical to use perfectly dry peat, more pounds of less heat value must be used. Assuming that the peat contains 33 per cent. of moisture, which seems to be the most practical state of dryness to attain, the two pounds of dry peat would be increased by one pound of water, making three pounds of wet peat necessary to develop one horsepower-hour. This would require excavating from the bog 240 tons of raw peat, with a content of 90 per cent. of moisture, each 24 hours to keep up a supply of 1000 horsepower. Bog peat has about the same weight as water (62½ pounds per cubic foot). I am assuming a bog undrained or imperfectly so, as the density of peat increases with the dryness of the bog.

An acre of such a bog would furnish 1360 tons of raw peat for each foot of depth, which, with 90 per cent. moisture, would yield 136 tons of dry peat, equivalent to 204 tons of peat containing 33 per cent. of moisture. Since a 1000-horsepower plant would consume 36 tons of fuel per day, one foot-acre of peat would last about six days, and a square mile one foot deep would last about ten years. These figures are based on an average, not a maximum, output of 1000 horsepower throughout the 24-hour day.

Drying the Peat

Climatic conditions have so great an influence upon the drying of peat that it is impossible to say how long peat must be laid out in order to dry sufficiently. I think that the season in the northern United States and Canada can hardly exceed six months and will in most places probably be less, unless the locality is one with slight rainfall. If the drying period is six months, then during that time the fuel for the whole year must be prepared. In the case of the plant of 1000 horsepower average output there would have to be prepared each day 72 tons of fuel, with 33 per cent. of moisture.

Most important is the time necessary to dry the peat. This varies with the extremes and middle of the season, set backs by rain, heavy dews and possible frosts; on the average, peat properly laid out may reach the necessary degree of dryness in from two to three weeks if it be not spread too thickly. As my object is not so much to show what has been done in specific localities, but to show the conditions attending a peat-power proposition, I will assume that the drying field, whether bog or upland, will be covered to an average depth of 4 inches and that the peat will be lifted every three weeks throughout the season of six months.

One acre of drying ground carried to a depth of 4 inches would contain 472 tons of fresh peat having 90 per cent. of moisture, or 71 tons of air-dried peat of 33 per cent. moisture. The acre of drying ground would be covered 9 times in the six months and the fuel produced per acre per season, that is, for the year, would be slightly over 600 tons.

The 1000-horsepower plant requires 36 tons of fuel per day or 13,140 tons per year. It would, therefore, require 22 acres of drying ground or not quite 1/30 of a square mile. I think that in most places this area would hardly be sufficient. Should the peat be laid out in cakes the space would be somewhat increased by the vacant spaces between the cakes, unless the cakes be made correspondingly larger. Peat in this form would dry quicker than in sheets and the efficiency of the ground would probably be much increased.

Experience has shown that the use of drying shelves is out of the question in handling such quantities of peat on account of the cost and deterioration of

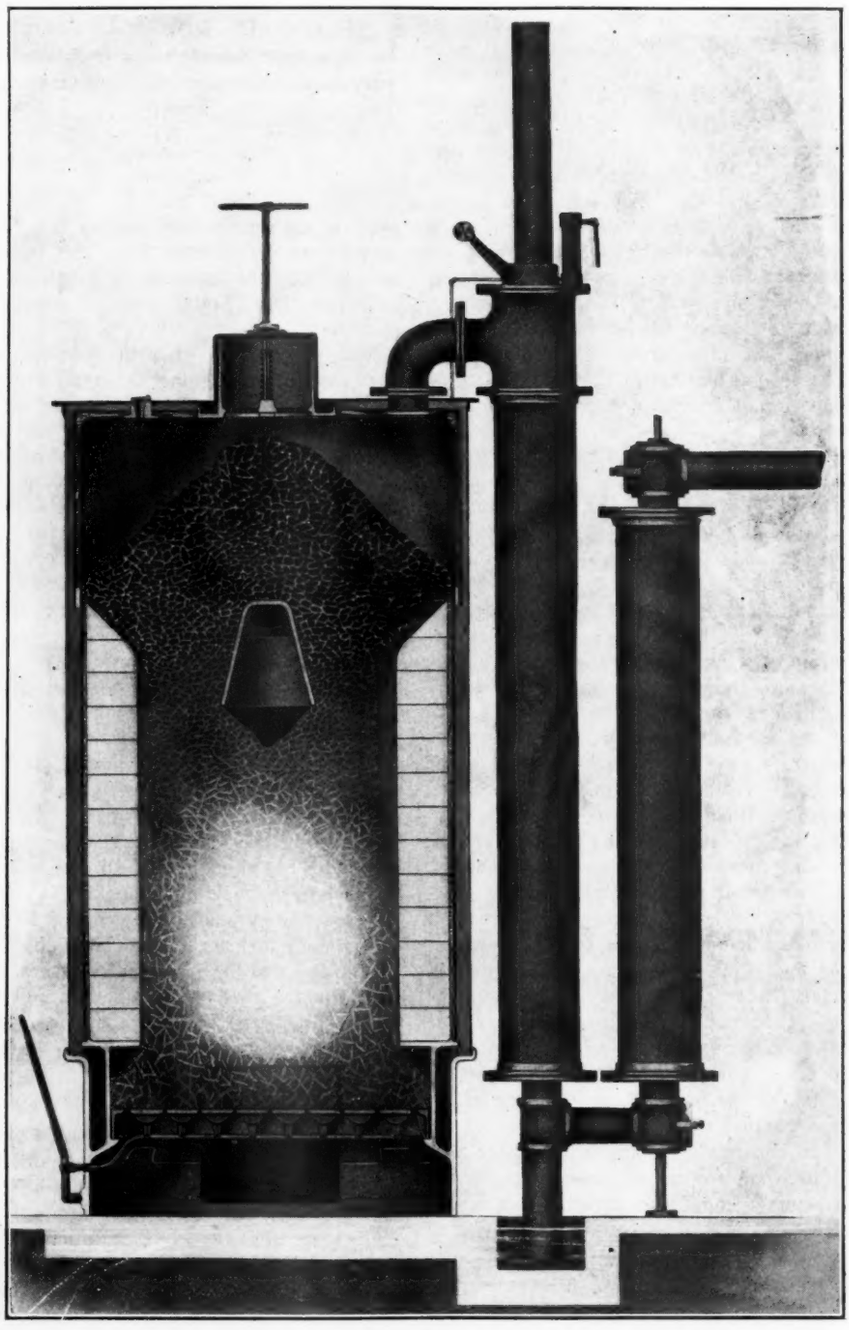


Fig. 1. The Syracuse Suction Gas Producer
(See page 1607)

the lumber. Further, it is not an easy matter to fill the shelves and unload them mechanically.

Two other ways of removing the water from peat are often suggested, pressing the water out and evaporating it by artificial heat. I would not say that peat presses are impracticable, but I do not think that the inherent difficulties have been overcome yet. It requires fine screens to hold the peat and great pressure to force the water out. Filter presses or machines of this type work too slowly to handle peat in large quantities. The requirements of a peat press are continuous and rapid operation, great strength, and screens that will not clog up and yet will hold the peat from passing through.

To remove a small percentage of the water would not be worth while using a press. However, if half of it could be removed by a press, it would be profitable to do this and subsequently air-dry the peat. The waste heat from the producer and the exhaust gases from the engines might be utilized in some way to finish the drying of the peat. The exhaust gases might be passed through the drying house, but the waste heat from the producers could not easily be utilized because it would require an enormous amount of piping, as the hot gas at this stage must be confined.

The peat should be removed from the drying field by mechanical gatherers. Strong and durable machinery is required. The gatherer must be designed to lift rather large pieces of peat and not clog or break. It must move on rails and be propelled by power. When loaded, it must carry the peat to the storage bins, which must be constructed so as to allow a circulation of air and at the same time protect the peat from rain.

If peat be dried to 50 per cent. of moisture or under it is uninjured by frost alone and can stand winter cold. It has been shown that peat should not dry too long in the hot sun because it becomes brittle. A better fuel can be obtained by partially drying on the field and finishing under cover with a good circulation of air.

As half a year's fuel must be stored for the winter it is evident that the storage plant must be quite large on account of the amount stored and its bulky nature. For the plant delivering an average of 1000 horsepower continuously, about 6500 tons must be stored, and as a cubic foot of peat fuel weighs about 25 pounds, the volume occupied by 6500 tons will be about 520,000 cubic feet.

Storage bins can be constructed so that even during the winter the peat will continue to dry.

By using machinery, peat fuel ought to be manufactured for $1 per ton or less. If so, it can compete with coal at $2 a ton.

The Syracuse Producer

The Syracuse gas producer, illustrated herewith, differs from the usual forms of updraft apparatus in several details, chief among which may be considered a hooded gas outlet below the top of the fuel bed in the generator and the use of a scrubber of a simple baffle type instead of the familiar coke- or lattice-filled tower.

The hooded gas outlet in the generator (see Fig. 1) does not carry the gases out of the generator but delivers them to the space in the upper end of the shell, above the fuel bed. Two pipes extend from the hood to points near the top head of the generator, the pipes being inclined at an angle of about 45 degrees. The opening in the hood which leads to one of these pipes is visible in the sectional view of the generator, Fig. 1.

The generator is built with a vaporizer in the upper end. This is not the usual deep "pan," but consists of a very shallow space between the two top walls and a very narrow annular space or "leg" extending down the side walls to a point about level with the gas-outlet hood. The body of water is, therefore, relatively small and thin; consequently the rate of evaporation is very flexible and can be changed suddenly to conform to sudden load changes.

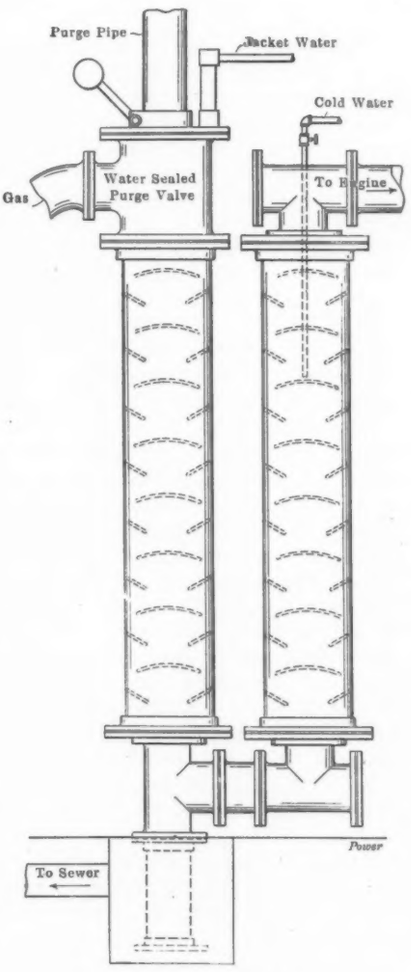


FIG. 2. SYRACUSE SCRUBBER

Besides the space between the generator walls which serves as a vaporizer, there is also a space between the inner and outer walls which serves as an air preheater. All the air passing to the ashpit goes through this space, which extends throughout the full hight of the generator shell. The air passes over the surface of the water in the vaporizer before entering the ashpit, and therefore carries steam along with it.

The annular space between the walls of the generator opens into a wider annular chamber in the cast-iron base which surrounds the grate and the bottom part of the fuel bed. This annular chamber constitutes a preliminary vaporizer, its function being to supply steam when the generator is being started up, before it has become hot enough at the top to evaporate the water there. The water supplied to the regular vaporizer in the top, not being evaporated, overflows the partition between the vaporizer "leg" and the air preheater, and runs down to the annular chamber around the grate, where it is evaporated by the heat from the freshly made fire. When the generator has got to making gas regularly, the ashes accumulated on the grate protect the wall of the "preliminary vaporizer" from the fire and prevent it from being damaged after all of the overflow water has been evaporated out of it. An automatic regulator then controls the supply of water to the top vaporizer and prevents any further overflow into the air-heating space between the shells.

The construction of the scrubber is indicated in Fig. 2. It consists of two large pipes connected at the bottom and containing a series of baffle plates over which the cooling water flows. The water discharged from the engine jackets is used in the first leg of the scrubber and cold water is used in the second leg. The idea underlying this method of scrubbing is that the warm water will remove most of the dirt and other solid impurities, as well as some of the sensible heat, leaving comparatively little work to be done by the cold water in the second leg of the scrubber.

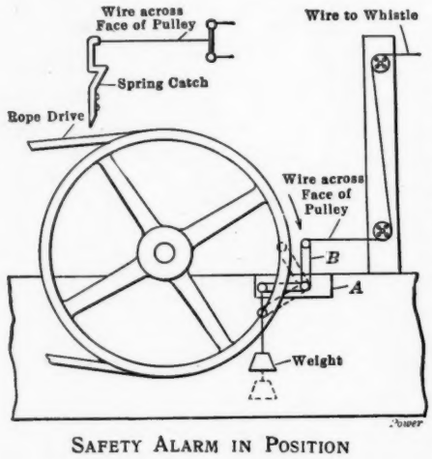
The grate in the generator is of the rocking type and is shaken by means of the hand lever shown at the left in Fig. 1. In order to prevent the formation of air passages through the fuel bed alongside the walls, which is apt to occur when the ashes are shaken off the edges of a grate, a stationary ledge is provided all the way around the wall at the grate level; this maintains a solid body of ash next to the wall when the grate is shaken. The generator is intended to gasify only anthracite coals, and is built by the Syracuse Industrial Gas Company, of Vernon, N. Y.

Readers with Something to Say

Safety Device for Rope Drive

The accompanying sketch represents an ingenious and handy safety device for rope transmission. It was used with much success at a plant in which I worked a few years ago. The plant was of 3000 horsepower and all the heavy machinery was run by rope drive. Before this device was installed considerable trouble and expense were caused by ropes breaking, but after its installation we were able to avert all serious trouble in this line.

The device is made in the following manner: A piece of iron plate *A*, about 5x8¼ inches, is drilled and countersunk at each corner, and an additional ¼-inch hole is drilled at the center. A second plate *B*, about ⅜x1x16 inches, is bent



SAFETY ALARM IN POSITION

into a right angle, and a hole is drilled at each end and at the vertex of the angle. Then both plates are loosely riveted together at the center holes and plate *A* is screwed to the engine frame or foundation. Thus the plate *B* is free to swing about the rivet as a pivot. Next, a spring catch, shown at *C*, is riveted to plate *A* in such a manner as to engage and hold the right-angled piece *B*. A wire is stretched across the face of the pulley from the spring catch to a pine stick held by screw eyes. To the vertical arm of *B* is attached a wire leading over pulleys to a steam whistle, and attached to the other arm is a weight.

Should the driving rope begin to break, the first loose strand will strike the wire, disengaging the spring latch from the lever *B* and allowing the weight to pull the latter into the position shown by the dotted lines. This causes a pull on the wire connecting the whistle and the latter blows, giving the alarm. Should the strand of rope hit the wire very hard, the pine stick will break and save the spring latch from damage. After the alarm has sounded, the engine can be shut down before any serious damage results.

EDWARD MORAN.

Columbus, O.

Practical information from the man on the job. A letter good enough to print here will be paid for. Ideas, not mere words, wanted.

Taking Indicator Diagrams

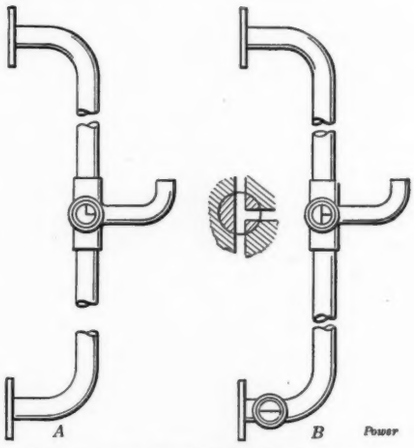
When taking indicator diagrams, two great hindrances to obtaining satisfactory results, assuming that the indicators are in good condition, are throttling of the steam and condensation in the indicator pipes. When an indicator is attached by a short length of pipe to the ends of each cylinder, these losses are reduced to a minimum; but two indicators per cylinder are somewhat of a luxury, not only because of the cost of an extra indicator, but if the engine be of long stroke, it means employing two men per cylinder in order to obtain a satisfactory set of diagrams.

As a compromise, it has become customary, especially in vertical engines, to have the indicator pipes arranged so that by turning a cock a single indicator may be connected with either end of the cylinder. The operator has a much better chance of obtaining satisfactory diagrams if he may stand still and merely turn a cock than when he has to move hurriedly from one instrument to another. The usual arrangement of the pipes is as shown at *A* in the accompanying sketch. The change-over cock is of the two-way type and usually has the two holes in the plug 90 degrees apart, although sometimes they are spaced at 120 degrees.

Though the pipes may be blown with steam before fitting the indicator, a certain amount of condensation takes place before everything is ready for taking the card; also during the intervals between taking successive cards, condensation will take place and the only outlet for the water is past the piston of the indicator; hence a large part of it remains in the pipes and instrument. The water in the pipes exerts a throttling effect upon the steam while the water in the indicator itself has an effect equivalent to that of adding a weight to the piston.

It is sometimes urged that a small amount of water will do no harm and I have heard it said by those who should have known better that since there is always a greater amount of steam than water in the leakage past the indicator piston, there should not be any fear of waterlogging the instrument. These men had evidently forgotten that much of the vapor which they saw coming from the relief holes of the indicator had probably leaked past the piston as water and had then been reëvaporated, owing to the drop in pressure.

I once had charge of a large triple-expansion engine which, for the maker's trial, had been fitted with an indicator at each end of each cylinder. The trial being satisfactory and the engine accepted, the indicator pipes were fitted as shown at *A*. Later, when another set of diagrams were taken, the engine developed apparently 5 per cent. less power under conditions practically identical with those during the maker's trial. The pipes were overhauled and found quite clear. They were replaced and carefully covered, but there was no perceptible improvement. Then an alteration was made in the pipes



USUAL AND IMPROVED METHODS OF PIPING FOR INDICATOR

which proved very satisfactory. The two-way cock for the indicator was converted into a three-way cock by continuing one of the holes through the plug; a second straightway cock was fitted close to the lower end of the cylinder, for the first cock, as altered, had no point for shutting off. This lower cock could be left open while diagrams were taken, as all indicators have a three-way cock of their own, in order to obtain the atmospheric line. When the cock is in the position shown at *B*, in which it should never be left for more than an instant at a

time, a quarter turn either way will connect it to either the top or the bottom of the cylinder. While changing from one end of the cylinder to the other, the cock is brought through this end position, and the momentary rush of steam will clear the pipes of any water that may be in them, also the greater part of the water from the instrument. This scheme is most useful in the case of the low-pressure cylinders of condensing engines, where the steam carries a large proportion of moisture.

J. A. EMERSON.

Newcastle-on-Tyne, Eng.

Shrinking on a Pump Gear

The article by H. S. Brown on the proper fitting of engine cranks, in POWER for June 14, brings to mind a bad accident, resulting in a large loss of time and money, which was caused by the attempt of an engineer unfamiliar with machine-shop methods to shrink a large gear on the crank disk of a hydraulic triplex pump. The pump was driven by a 225-horsepower induction motor and the gear was to be shrunk on over the crank disk, as shown in Fig. 1. The original gear had had six spokes, but owing to the frequent cracking of the arms the new gear was made webbed.

The gear was finished complete in the shop and the proper shrinkage allowance was made by boring the gear 32 thousandths smaller than the diameter of the crank disk, which was 30 inches, and delivered to the engine room. As the shop was very busy the engineer's request that he be allowed to shrink the gear on was granted. The first move he made was to suspend the gear from a crane near the pump and set it at the proper hight to shove onto the disk. A turnbuckle was used for close adjustment. The engineer was then left to finish the job, and about an hour afterward a loud report startled those in the vicinity of the engine room. Upon investigation a large piece of the rim was found cracked out, as shown in Fig. 2, and lying on the floor. The flame from three crude-oil torches had been concentrated on the heavy metal in the hub as indicated by the arrows in Fig. 3, instead of applying the heat to the whole gear uniformly, and the expansion of the hub had been resisted by the rim until its ultimate strength was exceeded and the gear cracked along the line of least resistance.

As there was no time to make a new gear, and also because the gear was a very expensive one, being 7 feet in diameter, it was decided to patch it. This was greatly faciliated by the webbed construction, and patches like those shown in Fig. 4 were applied and riveted into place. The gear has run satisfactorily for several years. The bedplate of this same pump cracked around several of the foundation bolts as represented in Fig. 5 due to the heavy upward thrust of the driving pinion and owing to the difficulty of gaining access to the foundation bolts a repair was very difficult to make. The method indicated in Fig. 6 was finally hit upon and the repair made without the necessity of longer foundation bolts, which would have been necessary had a plate or angle-iron patch been used, because anything placed under the nut would have left only a few threads of the bolt to be engaged.

H. F. RUDOLPH.

San Francisco, Cal.

FIG. 1

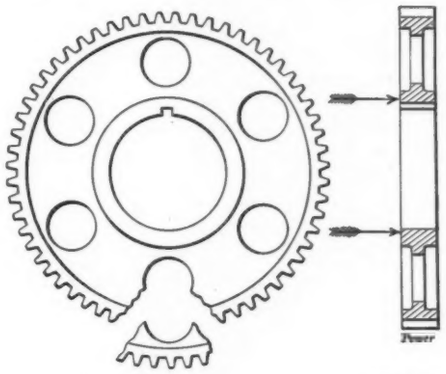


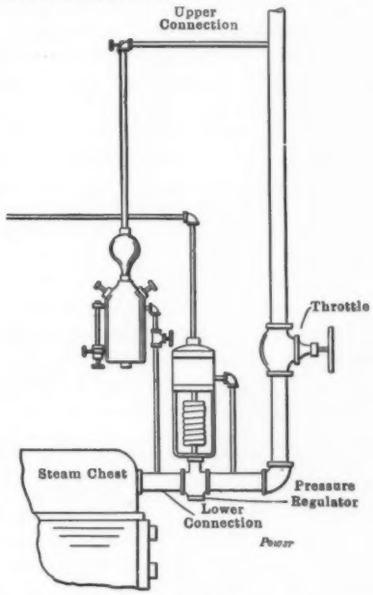
FIG. 2 FIG. 3

SHRINKING ON A PUMP GEAR

Defects in a New Plant

In a power plant with which I have recently been brought into contact, some rather surprising things are observed, especially as the equipment is new and apparently no attempt had been made toward the curtailment of expense in first cost.

The main steam line was found to leak at nearly every joint; occasioned, no doubt, by improper provision for expansion and contraction, or by inferior gaskets. This trouble was serious from the fact that the 10-inch line was near the ceiling and was surrounded with other pipe lines, all nicely covered and painted, but making the joints of the steam line almost inaccessible.



WRONG WAY OF CONNECTING LUBRICATOR

Another result of poor judgment in designing the plant is the use of a motor-driven centrifugal pump for pumping out a drip well located under the floor. The boiler blowoff tank drains into this well, also all the drips from the engines and pumps; consequently the water is hot all the time. The head is about 10 feet and the outfit serves only as an ornament and an unprofitable investment. Fortunately, all electrical apparatus is duplicated with steam-driven machinery and, by using a cold-water primer, the well is pumped out by an ordinary duplex pump.

Further evidence of poor design lies in the fact that two large three-cylinder pumps, connected by link belts to 30-

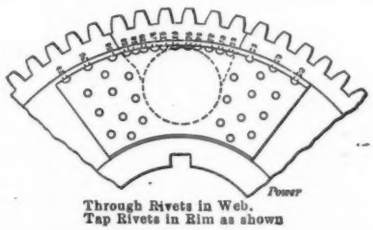


FIG. 4. THE PATCH

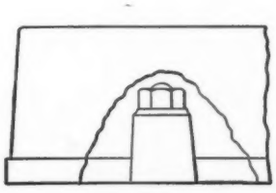


FIG. 5

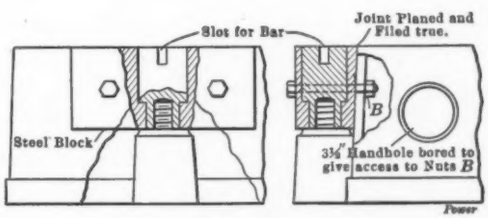


FIG. 6

horsepower motors, are provided to run the elevators. These pumps cannot be operated with the present electrical equipment, as the starting and stopping of the elevators causes an excessive variation in the voltage, consequently the steam pumps have to be used to run the elevators and the motor-driven pumps are merely to look at.

Another botch is the manner in which the lubricators are attached to the engines and pumps. They have double connections; the upper is attached to the steam pipe in the usual way, but the bottom one feeds directly into the steam chest or the line below the throttle. The lubricator cannot be operated until after the engine has been started, as the unbalanced pressure would empty the lubricator within a few minutes. This is particularly annoying in connection with the elevator pump which is controlled by pressure regulation.

The accompanying sketch shows that if the feed were properly adjusted to supply the pump while running, the lubricator would be emptied as soon as the pressure regulator cut off the steam supply.

Although this plant is new and supposedly modern in every particular, all coal has to be handled twice, and the ashes wheeled out in the old-time way.

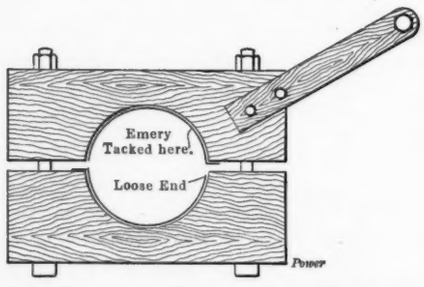
EDWARD T. BINNS.

Philadelphia, Penn.

Truing a Crank Pin

An arrangement for turning a new surface on crank pins, as shown in the sketch, is one which I have found very valuable and handy on work that would have been impracticable and expensive to have taken to the shops.

Two blocks of wood of the required size are bolted together with liners be-



BLOCK USED FOR TRUING CRANK PIN

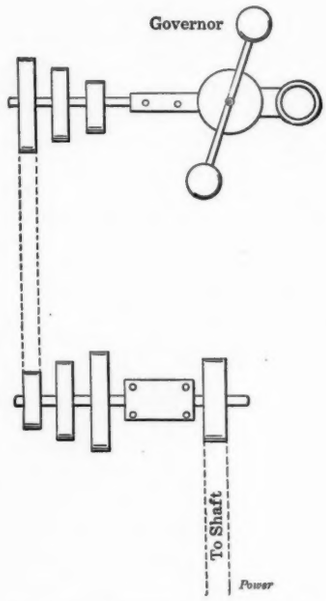
tween them and a hole is bored through the center of the joint, a little larger than the pin, which, of course, has previously been filed as nearly true as possible. The liners are then removed and around the inside of the hole coarse emery cloth is placed; this is fastened at one end by tacks in the open joint, and at the other end it is free. A strip of wood is fastened to the side of the block to form a crank for turning by hand. The apparatus is then clamped around the pin and revolved, using oil with the emery and changing to finer grades of emery cloth until the desired surface is obtained.

F. C. HOLLY.

Yazoo City, Miss.

Speed Variation with Throttling Governor

The accompanying sketch shows a simple method of obtaining a variable speed with a throttling governor. It is



PULLEYS FOR VARYING SPEED OF GOVERNOR

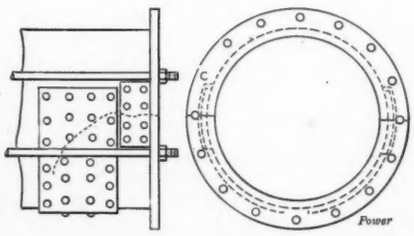
accomplished by the use of a set of cone pulleys which permit of 50 per cent. variation in speed, yet leave the engine under perfect control.

C. R. MCGAHEY.

Sheffield, Ala.

Patching a Broken Cylinder

The accompanying sketch shows the method of patching the cylinder of a



PATCHED CYLINDER

Corliss engine which had been cracked by the breaking of a follower plate. The cracks extended from the center on each side at the head end down to a point 18 inches from the head end, almost meeting at the bottom. Upon starting the engine the cracks opened up about 1/16 inch.

A strong clamping device, consisting of rods and bars was made and with the aid of a sledge hammer the crack was closed up until it was hardly visible. Then a 1-inch soft-steel plate was riveted on each side next to the flange and on the body of the cylinder a ¾-inch plate was riveted to each side. All the holes were countersunk and the rivets were driven cold with the heads left slightly high in the cylinder; these were afterward dressed off and polished. After all the rivets had been driven the clamping device was taken off and the crack remained closed. A groove 5/16 inch square was cut over the crack and calked full of soft copper. To further strengthen the cylinder, two 1⅛-inch rods were placed on each side, extending from head to head.

The cylinder has now been in service for some time, operating under a steam pressure of 150 pounds per square inch and is perfectly tight.

FREDERICK L. RAY.

Louisville, Ky.

Back Pressure

There seems to be much confusion regarding the term "back pressure" as applied to a heating system and to a refrigerating system.

In a steam-heating system the back pressure is obtained by introducing a back-pressure valve into the exhaust line of the engine; this allows all steam, in excess of the amount desired for heating, to escape. It has the effect of retarding the engine; that is, it is ahead of the engine and works against the piston.

Back pressure in a refrigerating system is the pressure of the ammonia, or other refrigerating agent, behind the compressor. This assists the compressor in doing its work. It is analogous to an ordinary water pump with the suction end connected to two tanks, one above the pump and the other below it. If the pump is started with the valve on the pipe leading to the lower tank open and the other tank cut out and the number of strokes counted; then if the valve on the line from the upper tank is opened and the lower tank cut out, the pump will be found to increase in speed. That which the water end is to a pump, the ammonia cylinder is to a refrigerating machine; which means that the back pressure on a refrigerating plant tends to assist the engine while the back pressure on a steam-heating plant retards the engine.

R. P. WILCOX.

Chicago, Ill.

Questions Before the House

Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues.

Information on an Air Lift

Referring to William Beaton's inquiry on "Air Lifts" in the June 21 issue, in my opinion the arrangement which he shows would not be entirely satisfactory, as it would be difficult to proportion the size of the air jets so that too much air would not escape through the upper opening, where there is the least resistance.

There should be a valve in each connection to properly control the flow of air. While this system is occasionally used, it is of no real benefit in overcoming deficient submergence as it admits the extra air where it does the least good. The air bubbles expand as they ascend the discharge pipe, which increases their lifting power, as they approach the top; and too much air in the discharge pipe, especially near the top, breaks up the water into spray and reduces the efficiency of the lift.

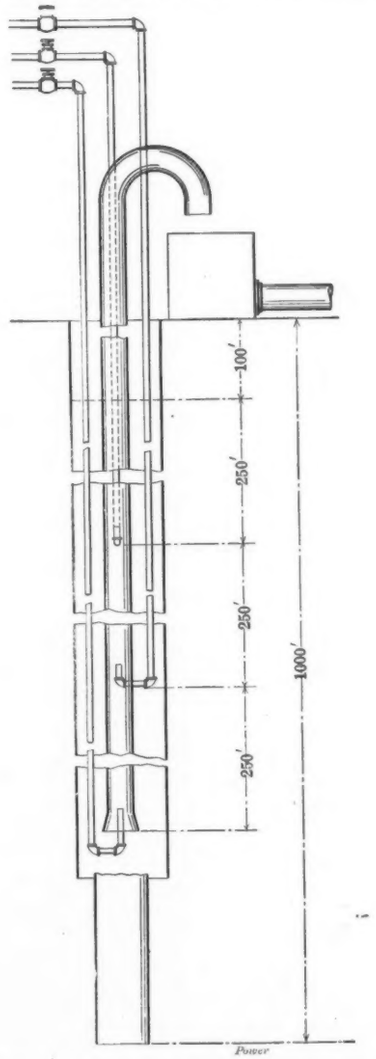


FIG. 1. AIR LIFT USED IN OILFIELDS

Fig. 1 shows the proper arrangement for this style of air lift as used in the oilfields, and arranged for a 1000-foot well. It is not used to overcome deficient submergence, but to make it possible to start a deep well, in which the hight of the liquid varies greatly between the pumping and standing levels, with a compressor capable of furnishing air at ordinary pressures only. The amount of air pressure required depends entirely upon the submergence. A pressure of 110 pounds will start a well with 250 feet submergence, but it will take 330 pounds to start a well with 750 feet submergence. It is seldom that more than one air jet is used at one time, the upper ones being closed as the level of the liquid in the well falls.

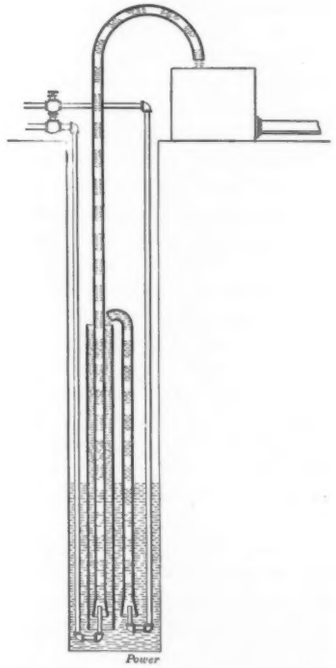


FIG. 2. METHOD OF IMPROVING DEFICIENT SUBMERGENCE

Fig. 2 shows the only way, known to me, of improving a deficient submergence, yet there are very few wells large enough to permit of this being properly installed.

With the correct proportioning and arrangement of pipes, the well under discussion can be pumped satisfactorily with the ordinary air lift, but not with as good economy as would be obtained with more submergence. From the figures given, the submergence would be about 31 per cent., while in the oilfields, wells are frequently pumped with a submergence of 25 per cent. or less. A submergence of 31 per cent. and a 110-foot lift with properly proportioned pipes would require approximately 1¼ cubic feet of free air actually delivered to the well (not compressor displacement) per gallon of water, and about 23 pounds air pressure.

G. A. REICHARD.

Los Angeles, Cal.

Discharged without Cause

In the issue of August 9 under the above title Mr. Wilcox relates his experiences. It seems to me that he was a victim of circumstances to a certain extent, and possibly hasty action by the chief based on information from others.

From the number of machines which Mr. Wilcox was responsible for, as well as from the fact that he was required to help in the boiler room too, I draw the conclusion that there was an abundance of nerve displayed by the boss in expecting so much of one man, not to mention the act of discharging him without inquiring more fully into the trouble.

As to Mr. Wilcox's advice to make a thorough inspection on going on and off duty, this should invariably be the rule, and in some cases precaution should be extended a little further. If anything should be found out of order and likely to cause trouble and offer a chance for a dispute if possible, call someone's attention to it, who is not immediately interested. As long as two or more men are called to work on the same job, just that long will there be chances for disputes; and no innocent man should suffer for another's mistakes.

The chief's telling him that he was hoodooed recalls my own experiences in a small plant several years ago. The company required good references before employing me. I had been on duty but a few days when one of the quarter-box adjusting bolts of the main bearing of the engine broke, causing a shutdown. The bolt had been strained for some time, as the break plainly showed, and finally came apart, though I had not touched it with a wrench. The boss said nothing about this, but his looks did not belie his feelings.

The water supply was from a small river some 800 or 1000 feet from the mill. An antiquated pump placed in a pit was used to force the water into an overhead tank. In about two weeks after my advent the pump failed, due to the suction pipe rusting through. This caused another shutdown. This time the boss said a few things until I convinced him where the trouble lay, but it was evident that his opinion of me as an engineer was nothing to boast about.

In about four weeks, while starting up one Monday morning, the boiler-feed pump showed signs of distress. Apparently it was working against an enormous pressure. I made sure that the valves on the feed line were open and then inquired how long the boiler-feed line had been in. Several years, was the answer and I was sure that the pipe was closed with scale. At 9 o'clock we were compelled to shut down and what I was told would fill a book. The boss said that the other engineer before me had never had any such trouble with scale and he did not believe that I knew what I was talking about. After he had got through I quietly informed him that in case I failed to find the pipe choked with scale, he could retain all of my wages. When the boiler was sufficiently cool I reached through the top manhole with a three-wheel cutter and cut the feed pipe, taking it out in two pieces. It was a good load for one man, it was so full of scale.

Of course, if my predecessor had remained another month he would have had the same trouble. It was a case of the new engineer and trouble being due at about the same time, and I was the victim of the circumstance.

JOSEPH STEWART.

Hamilton, O.

Pumping Layout

In answer to the inquiry of H. B. Fillmen in the August 9 POWER concerning the proper method of pumping several wells, I offer the following:

If it is possible, the use of a steam pump is preferable to an air lift. One pump is sufficient and will give better satisfaction than would an individual machine for each well. The steam consumption of the single unit will be less for equal work, as will also the friction losses and slippage. Further, the first cost of installation and subsequent maintenance will be lower.

Another thing to be observed is that probably these wells were bored one at a time and pumped individually. The yield then was 75 gallons per minute; but when all three are pumped simultaneously, it is highly improbable that the combined output will be anything like 225 gallons per minute. If 150 gallons are obtained from wells so close together the flow is unusually good.

In piping to the wells, a cross should be placed on the inlet of the pump and from it an individual pipe run to each well. A valve should be placed in each line, as it is unlikely that the quantity obtainable from the several wells will be equal. Each valve may be so set that the supply shall not be reduced in any one well so that air can come over and break the suction.

The original investment for a pumping system would be less than for an air compressor and its auxiliaries, and on the former the maintenance charges would be less.

The only occasion for using an air lift is when the water is so far below the surface that pumping is impracticable. Furthermore, water obtained in this manner cannot be used immediately but must be allowed time to free the entrained air.

In regard to the amount of air required to pump the well, the proposition with the data given is unanswerable. It is necessary to know the diameter of the well pipe and the distance of the water below the surface, as well as the quantity and the total lift.

TRUMAN D. HAYES.

Cambridge, Mass.

There is no need of more than one pump to do the work in Mr. Fillmen's layout. Make the suctions as straight and short as possible, and connect a gate valve close to the pump in each line, as often one well will give a better flow than another, and each can be tested or cleaned without interference from or with the others. Before using this layout be sure that the water will not recede beyond the limit of suction, a very probable occurrence. The Pohlé system of pumping by compressed air is in certain cases much handier and, if properly installed, should be more economical and satisfactory in every way. Its initial cost is higher, however. Its advantages are; the suction will never come out of the water; no danger of freezing in cold weather; no lost efficiency on account of air leaks in suction or worn packing, and less cost of upkeep. Another advantage of this system for artesian wells is that the constant rush of water low down in the well tends to keep the well clean, and to some extent increase the flow.

In installing this system there are two important points to consider if the greatest efficiency is desired.

First, the lift pipe should be submerged at least as much as the pipe extends above the surface of the water in the well. However, there is no gain in extending it more than one and one-half times the hight.

Second, no higher air pressure than is enough for the lift should be used.

This "enough for the lift" cannot be accurately determined, owing to lack of reliable data, especially as Mr. Fillmen has not given the size or depth of his wells. Figuring from tests on wells of this type, with equal lift and submergence, and with the air pipe running down outside the lift pipe, 75 cubic feet of free air per minute compressed to 40 pounds should handle 225 gallons 75 feet and give an efficiency of 60 per cent. from the receiver, the best that can be expected of this small size.

I would advise Mr. Fillmen to correspond with some maker of this type of apparatus, from whom much more accurate information can be obtained.

O. MONTHAN.

Tucson, Ariz.

Rumbling in a Boiler

In the August 9 issue of POWER there appeared an account of a "Rumbling in a Boiler," by M. H. Tarbell. Perhaps an experience which I had some years ago will help to solve the problem in this case.

The boiler was of 500 horsepower and had a 10-inch angle stop valve. It was reported to be rumbling badly under about the same conditions as are described by Mr. Tarbell. As this was considered dangerous, the fire was drawn and the boiler was allowed to cool. I then made a thorough internal inspection, looking especially for a loose feed pipe, loose stays or tools left in the boiler at the last cleaning, but found none and, moreover, everything appeared to be in good working order. Fortunately there was a gate valve between the main header and the stop valve. After bleeding the steam from the header the angle-valve bonnet was lifted off and the trouble was at once apparent. The disk had worked loose from the stem and the valve was working somewhat like a nonreturn valve. When the pressure in that particular boiler was low and no steam was being generated, the disk dropped onto the seat and remained there until the boiler again came up to pressure; then it should have lifted but as it fitted tightly into the body of the valve an excess pressure was necessary before the disk would lift. When it did lift the superheated water in the boiler generated steam so fast that it rumbled like the lid of a teakettle.

After the disk had been secured to the stem the rumbling ceased and no further trouble has been experienced.

CHARLES W. LONG.

Wilkes-Barre, Penn.

M. H. Tarbell does not state in his letter in the August 9 issue what kind of a boiler it is which acts as described. I assume that it is either an internally-fired boiler without an underflue or a tubular boiler with a return underflue which, from some cause, is not effective. When getting up steam the water around the tubes is heated, while below them it remains comparatively cold. As soon as the safety

valve blows, the water begins to circulate. This reduces the temperature of the steaming water and part of the steam is rapidly condensed causing a rumbling and chattering noise. The pressure will drop, of course, but is quickly restored by steam from the other boilers, if they are connected, and the heat from the furnace. The situation is not without danger as the reduction of pressure might cause an upheaval in the other boilers. I advise Mr. Tarbell to put the underflue in an efficient condition or to blow a little steam from the boiler intermittently while pressure is being raised in order to give the water a chance to circulate and acquire a more uniform temperature. I have had the same experience with portable boilers having round fireboxes. The steam pressure would drop from 75 to 25 pounds while the boiler was rumbling and shaking. Boilers suffer greatly under strains caused in this way and soon show defects, such as leaking tubes.

H. WIEGAND.

Indianapolis, Ind.

Accident to Blowoff Tank

In the August 9 POWER, R. E. Cooper shows a design of a blowoff tank and asks for criticism.

In my opinion the design is not half bad but it would be improved some if he would put an elbow on the blowoff pipe inside of the tank, and let it "look" in a horizontal direction either right or left so as to discharge the water around the inside of the tank. He shows a 4-inch vent pipe which is small enough for the purpose.

In regard to the tank which exploded, the wonder is that it did not explode sooner. It ought to be apparent to anyone that running the blowoff pipe to a point near the bottom of the tank or any distance below the water level is simply courting danger. In a tank of such design the water is lifted bodily from the bottom of the tank by the incoming water and vapor and projected against the top of the tank, especially if there is a leaky blowoff valve or if the water is thoroughly hot as it is likely to be after the first of a battery of boilers is blown down.

Another reason why the blowoff pipe should not be water sealed is that when through blowing down, the vapor in the pipe will condense and unless there is an air leak the pipe will fill with water which will become cool, and when blowdown time comes again a slug of hot water and vapor will shoot into a pipe full of cold water. Sometimes waterhammer does things.

A wonderful looking device is illustrated in the December 28, 1909, POWER. It is called a blowoff tank. If it possessed a few more trimmings such as a corn husker and a wheelbarrow it might be a useful article. A principal objection to it is that the blowoff pipe extends to a point near the bottom of the tank. The design must have been the result of a Welsh rarebit.

R. MCLAREN.

Berlin, Ont.

Leaky Floats

E. Granfield in the August 16 issue does not state whether the floats are for open-tank work, exposed to atmospheric pressure only, or for inclosed service and exposed to heavy pressure and possibly heat. In the first case solder will hold on any copper float if the float is properly cleaned and tinned before putting on the ordinary two parts tin and one part lead solder. This solder melts at a temperature of about 340 degrees Fahrenheit. A solder of one part tin and three parts lead melts at about 480 degrees.

If the solder is for floats of the second order the leak can be permanently stopped by using as a solder one part of hard spelter of zinc and two parts of copper. This solder melts at about 700 degrees. A blow torch or blow pipe will have to be used to apply it.

In either case the float should be heated considerably before attempting to solder, so that absolutely no moisture will be left on the inside. If ever so little is left, it is liable to blow through the solder when it is melted and leave a minute hole which may not cause much trouble at the start but will allow the float to fill gradually, and at the end of some days its usefulness will be gone. In all cases it is absolutely necessary to clean the copper around the leak before attempting to solder.

JAMES E. NOBLE.

Toronto, Can.

Packing a Feed Pump

In reply to George Kramer's inquiry in the August 9 issue as to the best method of packing a feed pump, I will say that I have been very successful in packing our feed pumps, which handle feed water at 210 degrees. The pump is 6x4x6 inches in size. It works against 135 pounds pressure.

I use 3/8-inch square hot-water packing. I let the packing lap about an inch or more by splitting it. It should not fit too tightly. The pump should be run fast after the packing is first put in until the water gets hot enough to make the packing expand. Some of this packing has lasted as long as six months under continuous operation.

I took the metal-expansion rings out of our pump, got a 3-inch brass sleeve, sawed it to the right length and used it to hold the packing in place.

T. P. THOMAS.

St. Paul, Minn.

Regarding George Kramer's letter on "Packing a Feed Pump," I submit the following:

All that I have used for years is square flax packing boiled in tallow. Any packing manufacturer can supply it. It comes to us on spools in sizes of 1/2, 3/4, 7/8 and 1 inch.

Our feed pump takes the 1/2-inch size; the stuffing boxes hold four rings. The feed water is taken from a heater and is at a temperature of about 208 degrees. I have had packing of this kind last for six months. I use a liberal amount of graphite mixed to a stiff paste with cylinder oil applied to each ring. The water pistons are of brass and not always in the best of condition.

J. P. COLTON.

Ohio City, O.

That Mr. Kramer's packing lasted but two weeks seems to indicate that some condition is not right as neither the temperature nor pressure is excessive. The first two "guesses" would be that the cylinder is scored or that the water contains some substance that disintegrates ordinary materials.

For impure water I have used leather packing with success. This was made up of leather washers cut from an old belt, the outside diameter to fit the cylinder and the inside to fit the piston body. This material has the advantage of being easily shaped to accurately fit the cylinder in case it should be worn out of round.

For gritty water, I have used for packing, cotton-cloth buffing wheels that have been worn small in the shop. The grit works down into the mesh toward the center leaving the surface clean. At one time, using this material, I ran an old pump, with a cylinder so scored that ordinary packing would not last two days, continuously for several weeks without renewing the packing.

T. D. HAYES.

Cambridge, Mass.

Will the Pump Raise the Water?

In discussing W. F. Callister's problem, as to whether a pump will lift water 10 feet if its supply is the discharge line of an impeller situated 70 feet below, both Mr. Sperry and Mr. French in the August 16 issue seem to agree that it will, but neither gives the real reason why it will. If the impeller will raise the water 60 feet against atmospheric pressure, it will, when the pump removes this pressure, force it up the remaining 10 feet into the pump. Mr. French's statement that the impeller must not prevent the atmospheric pressure from being transmitted to the water is false as that has nothing to do with the matter.

E. S. FITZ.

Cleveland, O.

Engineers' Wages

I notice the fact in POWER that a great number of engineers are getting their minds to work upon the wage question. This question, if followed up as it should be, is bound to bring results for the general good of both employer and the engineer. Good, conscientious, straightforward and painstaking effort will be appreciated and a prosperous condition in general will be the result of the final amicable adjustment of the wage problem. The article on the front page of the July 26 issue contains the expression, "Wages mean power. Not only the necessities of life, but almost anything in the world, except contentment, can be obtained for money." Very true indeed. An engineer's power, importance or ability is most frequently judged by the wages he is known to receive. If he gets good wages he must be a good man, and in nine cases out of ten you can bet your bottom dollar that he is giving his employer value received.

Some fellows are content anywhere and under any conditions, while others are not. One's individual makeup has largely to do with this, although it must be admitted that the wage question is about the first, the middle and the last consideration, even though all other items pertaining to the deal are satisfactory. Another article in the same issue, by E. F. Henry, clearly demonstrates the injustice to the engineer practised by the employer. Ability counts for nothing, everything is considered purely from the wage point of view. What are we going to do about it? It appears to me that right at this point a properly conducted and thoroughly organized Union would be a very important adjunct in regulating what we may call the knifing of one engineer by another. The union should be, as Mr. Henry says, for education, publicity and an arrangement whereby and in conjunction with the educational features the members could be given a rating in accordance with their proved ability. The union could then say to the employer, A man such as you require is worth so much. No one having the required rating can be secured for any less money.

Remember the old adage, "In union there is strength." Bring into a union means for education and the true fraternal and brotherly love features which are made mention of in the ritual of the N. A. S. E. and it is my opinion that an ideal union will be evolved, one not only satisfactory and agreeable to its members but one which employers will readily and kindly give recognition and support.

After a union is once on foot, I think that a universal system of operating reports and requisitions could be agreed upon which would not only enable the employer but the engineer as well to know just what conditions are and what is purchased and used in the plant each day. The reports should be in duplicate. They would thus afford an indisputable record. Mr. Henry's idea is good. Employers have the right to know where every dollar goes, and it is up to us to be capable of showing them. We will not be able to do this if we do not educate ourselves.

Our wages will always be down if we do not hang together. Dissatisfaction will reign supreme if we do not jump in and push together for the general good of all and exert every effort to eliminate all antagonism among ourselves or between us and our employers. In my opinion there never was much gained by fighting. Fight, of course, if the cause is just and there is no other way out. A man without some nerve and temper is seldom any good as an engineer, but the man who is able to control his nerve and temper is, as a general thing, the fellow that gets along the best with other men. He commands the respect of his employer, quite frequently to the extent of drawing the most money.

Let us then be up and doing
With a heart for any fate.
Still achieving, still pursuing,
Learn to labor,—educate.

T. M. STERLING.

Middlebranch, Ohio.

Trouble with Barometric Condenser

I read with much interest W. P. Elston's article in the August 16 issue of POWER stating the trouble with the barometric condenser under his care. My experience with a siphon condenser was identical to his, but, through relentless effort and observation, I finally succeeded in mastering what seemed to be an insoluble mystery.

We have a 500-kilowatt vertical steam turbine to which is connected a barometric condenser. The distance from the overflow of the well to the exhaust nozzle is 34 feet, the same as in Mr. Elston's case. Needless to say that practically every time I started the engine large quantities of water would come over into the exhaust pipe, and cause a terrible water hammer, after which I would have to drain this water out through an 1¼-inch drain pipe provided for the purpose at the lower end. The pipe was so small that the process of draining was very slow.

Eventually the fact revealed itself that a compound condensing engine with a direct-connected air-pump and jet condenser, when started slowly will form a vacuum in the exhaust pipe and condenser which will extend back into the receiver, because, having hardly any load, the governor will allow the steam valves to admit but a small quantity of steam, sufficient only to maintain a good vacuum. Therefore, if the injection water valve is opened wide instead of just cracked, through ignorance or lack of judgment, disastrous results to the cylinder are liable to follow. The condensing water will flow into the condenser unresisted and, not being removed fast enough by the air-pump, it will accumulate and soon find its way into the cylinder, where it will cause trouble if no devices are provided to get rid of it, such as snifting valves, floats with vacuum breakers, etc.

On the other hand, if the load is starting to come, the governor will allow the steam valves to open enough at each stroke so that pressure will soon exist on the exhaust side of the piston in the low-pressure cylinder, thereby preventing the advance of the water to the cylinder, and by regulating the injection-water valve, a good vacuum can be maintained under reasonable conditions.

If these facts are borne in mind when operating an engine with a siphon condenser, not much trouble should be experienced.

The way in which I start my engine is as follows:

First, I crack the throttle to let the engine speed up slowly. I then start the water pump, after which, when I observe by the ammeters on the switchboard that the load is being thrown on gradually, I open the throttle five or six turns and cut the condenser in immediately by closing the drip valve at the bottom and allowing the cover of the relief valve on top of the condenser to close, and by opening the top and bottom seals of the turbine.

If the siphon condenser is cut in before the engine has any load, it is quite certain that the troubles which Mr. Elston and I experienced will occur because it requires such a small quantity of steam to bring a turbine up to speed that the vacuum will extend way back into the first stage. But, when the load comes on, more steam is required, and with a pressure above the atmosphere in the exhaust pipe of the condenser no water can possibly flow back.

If Mr. Elston will bear in mind never to cut in his condenser before the load starts to come, he will experience his troubles no more.

LUKE MARIER.

Fall River, Mass.

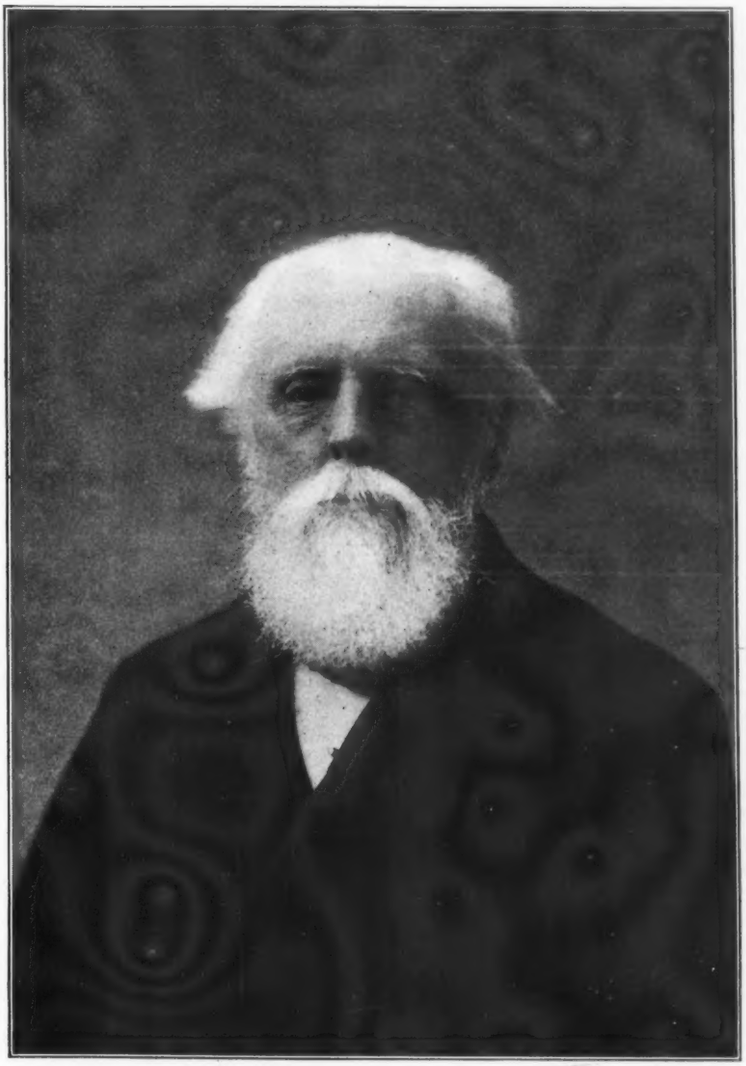
Safety valves are liable to stick on their seats; they should therefore be raised carefully at frequent intervals. Attach a small wire cable to the safety-valve lever, pass it over a pulley, and bring the end down to a convenient place for ready service in lifting the valve. See that the outlet to each and every safety valve is full size of the valve opening.

Charles Talbot Porter Dead At 84

On August 28, at his home in Montclair, N. J., Charles Talbot Porter passed away. He was born on January 18, 1826, at Auburn, N. Y. All that heredity could do for a man's brains was done for his. On his father's side he was a great-grandson of Jonathan Edwards, while through his mother he was descended from such New England families as the Phillipses and Winthrops. After graduating from Hamilton college, in 1845, he read law in the office of his father, Hon. John Porter, and thereafter practised for several years in Rochester and New York City. The college instruction of that day had taught him rather worse than nothing about mechanics, which proved to be his natural bent when he found it out. He soon acquired a disgust with the law, at which his clients seem to have been more proficient than himself. One of them beguiled him into a venture with a "centrifugal-force engine"—his first engineering experience—and another unloaded on him the patent of a stone-dressing machine. This machine, while impracticable as it stood, contained the germ of a good idea. Mr. Porter went to work to improve it, picking up by the way a knowledge of drafting and designing, and therein brought out his latent mechanical faculty so well that the machine proved a technical success and made its way commercially until the practice was introduced of sawing out, instead of dressing, the building stones for which it was intended and that fact destroyed its usefulness. The stone-dressing machine had been driven by an engine which governed faultily, to remedy which Mr. Porter was led to the design of his well known central-counterpoise governor (patented 1859). Into the manufacture of this he entered, equipping a shop in New York for the purpose. In 1861 Mr. Porter patented an isochronous centrifugal governor for marine work, which made its début on the German Lloyd steamship "New York," where it received high commendation. Previous to that time the engineers had been obliged to throttle their engine by hand.

About this period, Mr. Porter called on a New York firm of hatters in relation to their steam plant and there fell in with their engineer, John F. Allen, who showed him the design of a variable-cut-off valve and gear that he had worked out. It was agreed that they should attempt to apply this valve mechanism in connection with Mr. Porter's governor to a high-speed engine, and thus the Porter-Allen engine had its inception. The indicator was then little used in America, and one adapted to high-speed work was not obtainable. At this juncture, and at the instance of Mr. Porter, Charles B. Richards designed his first indicator. Mr. Porter bought the patent. An instrument for testing the spring was devised by him. With the success of the engine elements thus far brought together, Mr. Porter set himself to making improvements in details of design—cranks, journal boxes, eccentrics, etc.—and he prepared an 8x24-inch engine for the London International Exhibition of 1862. This was made to run at 150 revolutions per minute, since he justly apprehended that a speed of 200 revolutions would frighten people. As Mr. Porter sailed for England to look after his exhibit, there occurred the Mason and Slidell incident which brought that country to the verge of war with the United States, and when he arrived he found that the space allotted to American exhibits had been confiscated. However, he was permitted to install his engine to drive some looms, in place of one that had failed, though with the proviso that he should not exceed a speed of 120 revolutions. But the engine ran so smoothly that the speed limit was removed. After some time, the engine was sold to drive a foundry blower at high speed. The indorsement implied by the purchase helped to convert the apathy with which it had been received in England, because it was noncondensing, into a wave of interest and appreciation.

British orders for governors now began to come in. Mr. Porter busied himself with the standardization of the Richards indicator and its manufacture in England, one application being to locomotive service, on which subject he read a paper at Newcastle in 1863, before the mechanical section of the British Association for the Advancement of Science. Improvements in the bed and other features of the engine also occupied him, and he applied the engine to condensing service, soon designing a high-speed air pump for this purpose. He had, in fact, entered upon quite a protracted sojourn



CHARLES TALBOT PORTER, FATHER OF THE HIGH-SPEED ENGINE

in Great Britain. Arrangements were made with Ormerod, Grierson & Co., of Manchester, for the manufacture of the engine.

From England he took one 14x24-inch engine, making 150 revolutions per minute, to an international exposition at Oporto, where he gathered some interesting experiences. One day when he could not get steam to run the engine, he was condoled with by the king of Portugal, which royal recognition proved useful to him later in getting out of the country without a passport.

Upon the insolvency of Ormerod, Grierson & Co., he was approached by the Whitworth company, which informally took up his engine and set about constructing one for the Paris exposition of 1867. Mr. Porter's acquaintance with Whitworth led to curious obscurations of personality and practice. A proposed written agreement with him failed of execution because of the demanded incorporation of a privilege for Mr. Whitworth to alter the engine at discretion. To this Mr. Porter dared not consent, fearing the result of Whitworth's aggressive individuality in a field new to him. Mr. Porter took five engines to the Paris exposition. An application of Ducommon & Co., of Alsace, for a concession to manufacture under the patents was accepted, for which reason a proposition later made by Farco & Co., the most eminent stationary-engine builders in France, had to be declined. Zerah Colburn, the editor of *Engineering*, procured of Mr. Porter materials for a series of articles in that paper. In 1868 Porter read before the Institution of Mechanical Engineers a paper on the Allen engine which led to an animated controversy over piston acceleration, the actual rate of which Mr. Porter was the first to point out.

Mr. Porter's English residence now drew to a close. Having received from his friend, George T. Hope, president of the Continental Fire Insurance Company, of New York, an encouraging offer of financial support if he would return to the United States and join Mr. Allen in the manufacture of the engine, he set about the plan of a model shop to be arranged substantially in accord with one designed by Smith & Coventry, near Manchester, Eng. It was a type with nave, two-story side bays and traveling crane. He returned to America in June, 1868. His little governor shop on West Thirtieth street, New York, had been kept running during his absence.

Upon reaching America, Mr. Porter found that the financial backer of the enterprise on whom Mr. Hope relied had leased a small building in Harlem and provided Mr. Allen very inadequately with funds for its equipment. Mr. Porter succeeded in obtaining from him some additional capital and started work. Incidental to engine building, some straight-edges and surface plates were constructed. Mr. Porter acquired at this time a valuable foreman in George Goodfellow, who came to him from the Whitworth works and who followed him in future business changes. Before the end of the first year, the unnamed capitalist before alluded to proposed the formation of a stock company. He was allowed a controlling interest, became president and is charged by Mr. Porter with serious mismanagement. Resistance to his unwise policy brought Mr. Porter to the verge of ouster for insubordination, though the situation was temporarily saved by Mr. Hope, who bought out the control. But the expiration of the lease on the shop, coupled with a lack of confidence on the part of capital anticipatory to the panic of Black Friday, 1873, forced a closing out of the business. Just at the end, an engine was built for the Clinton Wire Cloth Company, whose work peculiarly demanded high speed and uniformity.

Two engines had been exhibited at the American Institute fair, New York, in 1870, together with the Allen boiler, recently designed. This boiler had tubes of independent circulation inclined slightly from the vertical, superheated 23 degrees, and proved a great success. In their report, the judges, President Barnard, of Columbia, and Thomas J. Sloane, proposer of the gimlet-pointed screw, said: "The performance of the engine is without precedent."

Before the windup of the business, Mr. Allen had left to enter upon the manufacture of pneumatic riveters, invented by himself.

Manufacture of the engine was suspended from the spring of 1873 to that of 1876. This interval Mr. Porter improved by revising and standardizing its design, room for the purpose being furnished him in the second story of Mr. Allen's little shop at Mott Haven. Resumption of construction work was effected by an arrangement with Mr. Phillips, surviving member of the firm of Hewes & Phillips, Newark, N. J. That establishment had of late been confining its attention to machine tools, in which business was so dull that a proposition from Mr. Porter was accepted to tide over the depression, even though he insisted in keeping the business in his own hands. In spite of a lack of ready money the construction of engines was carried on successfully.

The Edgar Thompson Steel Company, Braddock, Penn., at this time inquired for an engine to run a cold saw for rails, and Mr. Porter was able to furnish one which had been built to saw blocks for a wooden-pavement system that had been adopted for Washington, D. C., but abandoned. This led to sales of governors for other engines at those works and to the design of a new regulating valve.

At the Centennial Exposition, Philadelphia, 1876, Mr. Porter acted as a judge in coöperation with Professor Reuleaux, of Berlin, Horatio Allen, formerly president of the Novelty Iron Works, New York, and others. This furnished opportunity for some curious experiences and some caustic comments on human nature as well as on mechanical art. Mr. Porter took delight in describing to Professor Sweet the diminutive engine of his type that would equal in output the famous Corliss engine at the Centennial.

A 6x12-inch engine, to make 450 revolutions, was built for a bone-pulverizing mill at Newark, N. J., and on this engine was tried a new indicator invented by a young man who introduced himself as Harris Tabor. The diagrams proved free from such vibrations as the Richards indicator would produce at that speed, and with a certificate from Mr. Porter stating the conditions under which the cards had been taken, Mr. Tabor started for Boston to see Mr. Ashcroft.

An important share of Mr. Porter's attention was now given to building engines for rolling mills, and flywheel design came in for special consideration. An order from the Cambria Iron and Steel Company called for a 40x48-inch engine, larger than any that Mr. Porter had yet made, and most of the work, being too big for the Newark shop, was put out in Philadelphia. When installed, the engine increased the output of the roll train from 1200 to 3000 tons per week. The rapid action of Mr. Porter's engines was found incidentally to obviate the need of bloom chipping.

Before many years, the business had outgrown the Hewes & Phillips works and with Mr. Hope, who had an equal interest in it, Mr. Porter discussed the formation of a company with $800,000 capital, offering to assign his patents for $100,000 in stock. The Southwark works, Philadelphia, of the old engineering firm S. V. Merrick & Sons, were in the market for sale, and, impressed by their appearance, Mr. Porter advocated their purchase. The Southwark Foundry and Machine Company was now organized for this purpose though Mr. Porter had supposed that it would be called the Porter-Allen Steam Engine Manufacturing Company. From the start he began to meet disappointments premonitory of the obstacles later offered to his guidance of the work. A man connected with the earlier history of the establishment was elected president, while he was made vice-president with charge of manufacturing. At the start, an appropriation of $100,000 for new tools was refused Mr. Porter. The equipment proved to be in much worse shape than had appeared. A reissue of an important patent was needed at this time, and for some mysterious reason the patent solicitor opposed the idea of making application.

When made, it was at first rejected, but through Mr. Porter's personal activity was subsequently allowed. This saved Mr. Porter from inability to fulfil his agreement with the company but caused friction with the directors. Six months had passed without building an engine. Finally the desired appropriation for new tools was granted. Some were ordered from England; the modernizing of the equipment furnished Mr. Porter with quite a field for exercise of his ingenuity. Earlier in that year, 1880, he had participated in a meeting at the office of the *American Machinist.* at which it was determined to organize the American Society of Mechanical Engineers, and at its first session, held in Stevens Institute, he had read a paper on the strength of machine tools. A demand for engines for electric-lighting purposes was now created. Mr. Edison came along one day, wanting to buy a thousand engines but soon was convinced that he did not want more than twenty-four and finally concluded that six would suffice. Three Porter-Allen engines were actually installed for him. Overcharge, against Mr. Porter's advice, on an order for the Calumet & Hecla mine diverted business amounting to $100,000 in a year. A large engine was built by Mr. Porter for the Otis Steel Works, of Cleveland. Various engines were now being turned out, but difficulties of one sort or another met Mr. Porter at every turn, the chief obstacles being those within the works, where, in spite of the responsibility placed upon him for results, his ideas were disregarded both by those above and below him. As between him and the president, the directors chose to sustain the latter, and Mr. Porter's connection with the establishment ceased. The business—owing to bad management, the responsibility for which Mr. Porter has placed on others—was practically ruined, but was reorganized under management of James C. Brooks, then of the firm of William Sellers & Co., under whom it revived and has flourished.

Subsequent to retirement from connection with the manufacture of the engine that bears his name, Mr. Porter lived to spend a long and honored portion of his career, practising the engineering profession in New York City, while he resided at Montclair, N. J. Ill health, resulting from an accident, forced him to abandon work at times, but generally he was active and alert in spite of his advanced years.

Mr. Porter was the author of "A Treatise on the Richards Steam Engine Indicator and the Development and Application of Force in the Steam Engine" (1874), and of a work of more general character, "Mechanics and Faith" (1885), in which he ably showed why he, a man of science, could none the less accept as true things which belong to a higher realm than that of the senses.

At the instance of the editor of POWER, Mr. Porter wrote a most interesting series of "Engineering Reminiscences," which ran in that paper and in the *American Machinist* during 1903 and 1906, suspension through the interval being occasioned by Mr. Porter's health. They were later published in book form.

As a writer, Mr. Porter was possessed of a graceful, accurate and attractive style, which apart from knowledge of his history suffices to stamp him as one of the men of old-school culture who are not now found so frequently in the engineering profession as at a time when education for mechanical pursuits was less specialized.

On April 13, 1909, Mr. Porter was awarded the John Fritz medal, which was established in 1902 by the profession of engineering as a meed of recognition for notable scientific or industrial achievements.

The story of his life constitutes a history of the rise of the high-speed engine.

Dwelshauvers-Dery's Laboratory

By F. R. Low

It was my recent privilege to be shown by Prof. V. Dwelshauvers-Dery, the distinguished professor emeritus of the University of Liège, through the laboratory of steam engineering which he proposed, when such a laboratory in connection with a university was unheard of, which he secured only after years of perseverance, and in which were conducted experiments which have made both the university and the experimenter famous in the field of steam engineering. In a corner of a little courtyard, with quiet paths and mouldy trees it stands, a modest little one-storied building with no suggestion of industrialism or mechanics in its appearance or surroundings, reminiscent of the attitude of the grave and learned dispensers of culture, of the date of its inception; that is, if such an innovation must be tolerated it must be subordinated to the classic atmosphere of the university. Passing through the anterooms and offices one reaches the laboratory proper in the center of which is the famous engine of Beer which, under the skilful manipulation of the professor and his corps of trained assistants, furnished the data for so much information as to the actual operation of steam in a cylinder and the relation of that action to the abstract laws which were supposed to govern it. This engine has so lately been described in POWER* that it is needless to repeat the description here in detail. The guides carry a scale divided into thousandth parts of the stroke (0.60 mm.) with a vernier which enables one to locate the position of the piston to the six-hundredth of a millimeter and the valves, which are riding cutoffs, have their separate scales and verniers, six in all, two for admission and one for exhaust upon both head and crank ends, all reading to the tenth of a millimeter. One original Richards indicator purchased at the exposition of 1862 is still upon the engine and we were shown the method of calibrating the indicators by dead-weighting their pistons. They are still so free from friction that the lines drawn when removing the weights coincided almost perfectly with those drawn when the weights were added. The reduced motion is taken from a rod sliding beside the indicators operated by an eccentric and rod having the same proportions as the main crank and connecting rod and the only cord is that, some 6 inches in length, used to connect the paper drum to the reciprocating rod, so that the movements of the piston of the engine and the paper of the indicator are strictly proportional.

Behind the engine is the measuring tank for the water, fitted with a weir and with an apparatus for measuring the hight of the water so delicate that the addition of four or five drops in a tank containing some 500 gallons will bring the water level into contact with a metallic point and produce a very apparent indication (a sort of inverted Hookes gage). The water level is measured with a scale which has to be read with a lens.

It is Dwelshauvers-Dery's pleasure and boast that his laboratory has turned out real scholars and experimenters; notably Georges Duschene, whose continuation of the work begun with the professor upon the interaction of the working fluid and the cylinder walls was brought to an end by his untimely decease, and Armand Duschene, his brother, who is carrying on the work in the same laboratory at present. With delicate thermocouples of silver and platinum wire exposed to the steam or embedded in the cylinder walls, he measures the varying temperature throughout the revolution and is able to plot diagrams of the temperatures of both metal and fluid for all sorts of conditions.

It is easy to determine the volume of the cylinder up to some point after the admission valve has closed, including that of the clearance. The pressure at this volume can be measured from the indicator diagram; the weight per cubic foot

*June 28, 1910, page 1159.

found from a steam table and this weight multiplied by the volume and the number of times it is filled per hour would be the amount of steam used per hour *if it were always steam.*

The steam consumption calculated from the diagram in this way is always less, usually by 20 per cent. or more, than the steam actually furnished, as was determined by weighing the feed water. This is because the steam parts with its heat to the cylinder walls and is present as water at the point in the stroke at which the pressure is taken from the diagram. This investigation of that action is therefore very interesting as throwing light upon this "missing quantity" the reduction of which is the main object of jacketing, compounding and superheating. Professor Duschene has promised to prepare for POWER in the early future a résumé of his work, including his latest and unpublished results.

Another of Professor Dwelshauvers-Dery's scholars, Professor Hanocq, is conducting in the same laboratory a series of interesting experiments upon centrifugal pumps. A pump is motor driven, the motor being also fitted with a prony brake. Connections are made to the induction passage and to various points in the diffusion vanes, and the vacua and pressure measured by mercury manometers. The water handled can be accurately measured, the efficiency of the motor under all loads is determinable, and the input of energy is shown by the electrical instruments, so that the efficiency of the pump, which may be changed from single- to two-stage, may be accurately measured under various conditions. The leakage is determined by blocking up the openings in the impeller and pumping water into the pump at various pressures, only that passing which the clearances will allow. The leakage may be thus measured either while the pump is standing or running. The investigation promises to be interesting, but has not yet progressed far enough to be discussed.

Professor Dwelshauvers-Dery is passing his period of well merited repose in a charming home upon the banks of the Meuse, across which he can look upon the scene of his earlier activities. As Dr. R. H. Thurston, accustomed to the much greater resources of Sibley and of Ithaca, once said of it to him, "It is a small equipment but it has turned out great work."

Improvements not Appreciated

By W. Osborne

The job was not a nice one but the man who came along with it was one who talked in a pleasing way. He had come a long way, more than twenty miles, across the country to reach this shop because he had heard that good work was done, that special efforts were put forth when a man was in a hurry and that a fair price was charged. Besides he had a job that he must take back with him.

This job proved to be the cylinder of a sawmill engine. It had been 12x16 inches originally, which was a long time ago, but had worn and been rebored until it was about 12¼ inches diameter and in need of reboring, but the place where it most needed repairs was in the steam chest.

The valve seat was worn down so that the ports had lengthened out and finally got down beyond anything provided in the original plans of the designer. The valve was a single D valve moved by a fixed eccentric. The steam distribution must have been very bad even with things in good shape.

After looking things over it was decided to make a false valve seat and new valve, and to rebore the cylinder and put in a bull ring with two snap rings.

This job had been brought to the shop shortly after seven o'clock in the morning. While a cut was being run through the cylinder a sketch was made and given to the patternmaker. That evening a valve and seat were cast in the foundry. The next day they were fitted and the seat secured to its place in the steam chest with brass screws. After fastening a cut was taken over it. The balance of the job had been done, but according to good practice the valve and seat should be scraped together, and there was another little point that had not been attended to. To get in a seat of reasonable thickness it had been necessary to leave very little clearance between the valve stem and the valve.

It had been explained that it would be necessary to watch things for a few days for the valve scraping had not been as well done as it would have been with more time available. Everything seemed to be understood and away went the man.

Two weeks later a letter was received. It calmly and judiciously set forth that the job done had been one to make even sawmill mechanics blush. Nothing had been right.

This letter came in the morning mail and after reading it the owner of the shop handed it to the young man who had been in charge of the job and who had done most of the work on the planing and fitting of the valve and false seat.

Without a word he handed it back and began to take off his overalls.

"What does this mean?" asked the owner in surprise.

"It means that I am going to see that job, if it is the last thing I ever do," was the reply.

Seeing his determination the owner told him where he would find the store which this man owned and where he could find the mill, even if he did not find the writer of the letter.

At the mill it was found that the engine was not in good shape. It was certainly working hard and making hard work of it. To help out the bolts a piece of timber was wedged from the steam-chest cover to a beam and another one from the cylinder head to another beam. Even with that help both joints were leaking. The steam gage on the boiler showed 100 pounds and the throttle was wide open. To furnish lubrication for the cylinder there was an old-style tallow cup that would hold about four ounces. It was tapped into the side of the governor body. The fireman explained that it was put there so that it could be filled. There was a valve made to be closed when the lubricator was being filled but this valve leaked so that it was necessary to close the throttle valve and shut the engine down to fill it. The worst sin that a man could commit around that mill was to stop it even for a minute. He also explained that the cylinder had arrived in the night and had been put on without any lining up. It had been found that it did not line with the crosshead and the piston bull ring had been filed so that things could be got together. The valve should have been filed to let the stem down a little farther, but instead of that it had been sprung enough to connect up. The eccentric had been rolled around so that the steam was admitted at the right time. It had taken until morning to get it going and it was allowed to run along without any load until the fireman and the men helping him had got breakfast. It then had been put to work pulling the mill and had run twelve hours a day until the Sunday following. On being examined the cylinder had been found somewhat cut and the valve and seat quite badly cut. The fireman could do very little except report their condition, and the letter resulted.

The millowner defended his position in the matter by referring to the practice on a little narrow-gage road that ran near. The master mechanic of this road was a friend of his and had posted him on all that was good practice.

Rather than have or make trouble the bill was paid, but so strong was this man's faith in his friend, the master mechanic, that he believed that all trouble would have been saved if the job had been planned and done by him.

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Power and The Engineer

Editorial

Shop Inspections

When apparatus is built for a plant erected under the supervision of a consulting engineer, it is generally specified that it shall be inspected or tested at the shop to the satisfaction of the engineer before acceptance. Often in such cases the manufacturer is seriously embarrassed by the incompetence displayed in making the inspections. In most cases the consulting engineer is not an expert on the constructive details of all the apparatus necessary for even a small installation; and it is not a reflection on his ability, and should not hurt his pride, to acknowledge the fact when occasion may warrant it. Instead of taking this view of the subject, however, the consulting engineer often assumes that with his superior general knowledge of mechanics, he can make a bluff at the job and get away with it, without anyone being the wiser. He can generally fool his patron in such an attempt, but he never deceives the manufacturer regarding his ability.

Almost invariably the novice endeavors to impress the builder with his carefulness by picking flaws with details that could not possibly affect the usefulness or life of the apparatus, and if there should be faults to warrant a real kick, he usually fails entirely to notice them.

For example, in inspecting boiler work, great stress will often be laid on the exact spacing of the rivets, regardless of whether variations from the specifications noted affect the pressure required or not, while the laps at the longitudinal joints may be so short that the rivet heads come to the edge of the plate without causing comment. Undue calking of rivet heads, denoting poor riveting, will entirely escape his notice if the rivets have been made tight before pressure is applied; while a hair-line crack on the beading of a tube will call for his earnest remonstrance regarding the workmanship or the material. Whether the tightness displayed under the pressure test is produced by well fitted courses or undue calking is a matter that he does not understand the importance of determining, and no attention is paid to it. An inspector who is thoroughly posted on his work and has confidence in himself does not think it necessary to make a kick simply to show that he has performed his duty, but the novice generally assumes that the acceptance of apparatus without any fault finding is looked on as lack of care on his part rather than an indication of carefulness in manufacture.

If a consulting engineer has reason to doubt the honesty of a manufacturer, and is not himself an expert in the details of construction of the apparatus to be inspected, he should employ an inspector who is thoroughly qualified to perform the work; for only in this way can his client's interest be fully protected and justice be done the manufacturer.

As the Field Broadens

One of the salient features of the proposed Institute of Operating Engineers is the admission to full membership of only those who can demonstrate that they are operating engineers in the full sense of the term.

It is not expected that these men will be required to show that they can design boilers, pumps, engines and other power-plant machinery, but it is required that they shall have the mental attainments and possess the manual skill necessary for the operation of any power-plant equipment and the management of all classes of workers connected therewith.

As one after another of the callings, vocations and trades have by the application of labor-saving and labor-displacing machinery become comparatively simple craft operations and the skilled workers reduced to the status of "hewers of wood and drawers of water," the field of the operating engineer has broadened and the responsibilities have increased to a degree realized only by a few.

Not many years ago the generation and transmission of power concerned the engineer only to the extent of the physical processes occurring between the coal pile and the flywheel rim, and he covered that field only in a general way. Today his field embraces the composition of the coal before it is piled, that of the gases that go up the chimney and the transformed energy of the steam far beyond the switchboard. From being a general worker in one comparatively narrow field he has found it necessary, in order to keep abreast the times, to be an expert in several broad fields.

Anything that has to do with moving machinery is the operating engineer's field, and as one new form of power transformation after another has been developed—the high-power waterwheel, the

electric generator and motor, the hydraulic and the electric elevator, the steam turbine and the internal-combustion engine, as well as the machinery they drive—they have all been placed in the care of the engineer. It is the purpose of the Institute through its subsidiary branches and correspondence system to prepare apprentice and junior members for full membership by systematic training.

Apprentices and junior members are the foundation on which the Institute will be built and the man who passes through the lower grades to full membership will demonstrate by his progress that both mechanically and mentally he has earned his standing in the organization. In this connection it may be interesting to know that hundreds of able and prominent operating engineers from all parts of the country are giving the matter of organization their serious attention, and universities, colleges, schools and extensive employers of skilled operatives have promised hearty coöperation in the effort to found and support the proposed Institute, in recognition of its object to furnish the industries of the country with a class of men whose skill and fitness for responsible positions will be practically assured.

Entropy

Time was when the practical engineer did not have any use for entropy; if he ran across the word he considered that it referred to some abstruse theoretical matter that was interesting to professors; if he had been harassed by the conception as a student he put it from his mind and turned his attention to real things.

But the steam turbine has changed all this and now the practical engineer is confronted by entropy diagrams and entropy tables. What is entropy any way? Various answers are given to this question, depending on the point of view, and all are more or less correct.

Now entropy was originally a mathematical device invented independently by Clausius and Rankine for solving problems in steam engineering; Rankine called it the thermodynamic function, and Clausius invented the name now adopted.

In order to understand the reason for such a device it will be necessary to look a little further back in the history of thermodynamics. The first experiments in thermodynamics were made on air because they were the easiest, and fortunately the properties can be expressed by comparatively simple equations. For example, at constant temperature the volume is inversely proportional to the pressure, and at constant pressure the volume is directly proportional to the absolute temperature. These laws can be combined into an equation with three variables,

$$pv = RT$$

Coming now to steam, the experiments were vastly more difficult and were dangerous, and it was only when the French government gave Regnault a subvention that anything like precise knowledge could be obtained. His results have remained standard partly because he was an exceptional experimenter and even more because of the great difficulty of making better experiments. It is, as it were, but yesterday that better experiments have been completed and even these have nowhere near the precision of experiments on air.

In order to find the influence of the externals on the behavior of a substance like air or steam it is necessary to determine first how they would behave without such interference and such investigations must be made by computations because the externals like the walls of a steam-engine cylinder are always with us. Such an investigation can be made easily enough for air, resulting in the well known adiabatic equation for air, and there is no reason for injecting the conception of entropy into this discussion, although it commonly gets there. As a matter of fact the equations were deduced before the function or device called entropy was invented.

But when it comes to saturated steam it will be found that all the properties, pressure, volume, total heat, etc., depend on the temperature and the derived equation with three variables that would be derivable is not forthcoming. The three variables are there and this becomes evident when investigation is made of the adiabatic action of steam, for some of the steam condenses and gives the so called dryness factor usually represented by the letter x. This represents the part of the steam which is not condensed, so that $1 - x$ is the water of condensation.

Now if there are three variables and it is desired to calculate a numerical result, it is very convenient to get rid of one of them. In the case of air there is a convenient example in isothermal expansion represented by the equation

$$pv = constant$$

All that is necessary is to put in a value of p and calculate v. The adiabatic equation for air is nearly as good, for with logarithms the same thing may be done with that equation.

But for steam there is no such royal way. There have been attempts to make approximate equations of that sort for steam. Rankine worked out an exponential equation but it is not general enough.

Turning to the isothermal for air once more, the trick is done by making the temperature constant; a mathematician who is used to thinking in abstractions has no difficulty at all in dealing with the adiabatic action in like manner. He says, Let us try making something constant; we do not know what its form will be and it has no name, but at any rate assume that there is such a thing (only he calls it a function) and see what happens. In the case of steam the result was inevitable, for Clausius and Rankine worked it out independently and no one has been able to work out anything else. This is no place for the analytics of the case. which can be found in any textbook on thermodynamics.

The whole matter is further complicated by the reason that the professor, being original, saw at once that if there was an entropy for steam there must be one for air and proceeded to determine it. And he has good reason for dealing with the entropy of air when teaching students, for the whole discussion is easier than steam. But nobody except the professor and the students who suffer under him have any practical use for entropy of air; and the only reason for computing numerical values is to show that it can be done, which is more interesting than useful.

There is one inconvenience about adiabatic computations for steam—they can be made forward but not backward; a pressure can be assumed and the corresponding volume computed, but if a given volume is desired there is nothing to do but guess and try. It is easier to make several computations and draw a curve. Hence the reason for temperature-entropy diagrams for steam. Such diagrams must be on a large scale, but they are otherwise convenient. A table is even more convenient and more precise. Anyway, the engineer has only to learn how to work the diagram or the table and he gets his results and can leave others to wrangle over meanings and philosophies.

Now the engineer is the man who does things; if he can invent a way for himself, or if someone will do the trick for him, and if he gets results, he is satisfied. But the physicist is a man who finds out things, and whenever he has a device which will do one thing, he tries to see if he cannot do something else with it. So he does not rest content with the idea that entropy is a device for solving problems in steam engineering; he enlarges and develops the conception and uses it for other purposes. From this come the various conceptions concerning entropy.

Leaky valves are as bad as a hole in your pocket.

A monkey wrench makes a poor hammer; don't use it for one.

Putting up a line of steam piping means more than cutting threads and screwing lengths of pipe together.

The fellow who is making the most of a small job is far ahead of the fellow who is making a botch of a big one.

Inquiries of General Interest

Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it.

Proper Heat for Babbitt

How can I tell when babbitt is hot enough to pour when babbitting shaft boxes?

D. J. C.

When the melted metal will char a pine stick thrust into it, it is hot enough to pour satisfactorily.

Efficiency of Joint and Change of Pitch of Rivets

In a boiler, if the pitch of the rivets is 2½ inches and the efficiency of the joint is 72 per cent., what would be the efficiency of the joint if the pitch were changed to 3 inches?

C. H. F.

If the joint with a pitch of 2½ inches was correctly designed the plate and the rivets would be of equal strength and increasing the pitch without increasing the diameter of the rivets would weaken the joint in proportion to the increase in pitch.

Babbitt Sticking to Shaft

Will babbitt stick to an ordinary shaft if the latter is not oiled?

D. J. C.

In some cases it will, especially in the case of bearing shells, such as are used on many high-speed engines. It is better to coat the shaft with plumbago (black lead) or chalk before pouring. When babbitting bearings for shafting it is better to employ a mandrel the size of the shaft. The heat from the babbitt may spring a shaft of small diameter, if it is of steel.

Variation in Gage Readings

In a battery of boilers is it possible for the steam gages to indicate a difference in pressure? Is so, what is the cause?

S. R. B.

It is not only possible, but quite probable that when a number of gages have been used for a considerable length of time the pressure indicated by them will vary to a slight degree, say, from 1 to 2 pounds.

When the gages are connected up exactly alike and subjected to practically the same temperature, the difference is due to the effect of the alternate expansion and contraction of the spring, or to the fact that the springs have become "set" at different pressures.

The difference in pressure may be due to different vertical distances measured between the bottoms of the gages and the points at which the gage pipes are connected to the water columns or boilers. The gage pipes being of different lengths contain varying "heads" of water, which produce corresponding variations of pressures in the gages.

Composition of Coal

What is the composition of bituminous coal?

B. B. L.

A good quality of bituminous coal contains about 61 per cent. fixed carbon, about 31 per cent. of volatile matter, known as hydrocarbon, 7 per cent. of ash and 1 per cent. of sulphur. The exact composition depends on the quality of the coal, etc.

Air Supply in Combustion

Why is it necessary to provide a supply of air for combustion in the furnace?

J. W. B.

As combustion can only take place through the union of oxygen with combustible matter and as the only source of oxygen is the air, it is necessary that air pass through the fuel in order to become thoroughly mixed with the volatile matter and gases being distilled from the fuel. If the air is allowed to pass over the fire, very little of the oxygen can combine with the combustible matter of the fuel.

Duplex Pump Cushion Valve

Please describe the operation of the cushion valve on duplex pumps.

L. A. M.

A duplex steam pump is generally provided with four ports connecting the steam chest and cylinder, the two outer ports admitting steam only, the two inner ports being used for exhaust steam only. A small port or bypass connects the steam port and the exhaust port at each end of the cylinder, the bypass being opened and closed by means of a valve called the cushion valve.

When the cushion valve is closed the steam in the cylinder escapes through the exhaust port into the cavity under the valve and thence into the exhaust pipe. When the piston covers the exhaust port the escape of the steam is shut off and what remains in the cylinder is compressed in the clearance space, arresting the movement of the piston before the end of the stroke is reached.

When the cushion valve is open the exhaust steam flows through the bypass from the steam port into the exhaust port, reducing the volume of steam compressed in the clearance space, and the stroke of the piston is lengthened. By manipulating the cushion valve according to the speed of the piston, the length of the stroke may be regulated and the piston prevented from striking the cylinder head.

Necessity of Air in Combustion

How can you prove that it is necessary to supply air through the fire for combustion?

W. R. O.

By shutting off the air supply, either by closing the damper or allowing the fire to become so thick or clinkered that the air cannot pass through it.

Combustion

Why must air be heated before combining with the coal?

J. A. D.

The air does not combine with the coal, but the oxygen in the air combines with the combustible matter in the coal. It is the combustible matter that must be heated before oxygen will combine with it.

Drilling Boxes for Babbitting

Is it necessary to drill holes in a box to keep the babbitt from coming out or working loose?

A. W. B.

For bearings for line and countershafts it is not necessary to drill holes for the purpose of keeping the babbitt in place, but it is quite necessary to do so in the case of connecting-rod brasses, main bearing boxes and all bearings that are subjected to shocks and the reversal of the direction of rotation. In the latter cases it is better to pene the babbitt thoroughly and then bore the brasses or other bearings to the size of the shaft or pin.

Operation of Dampers

What effect on combustion has the closing and opening of the damper?

H. M.

Closing of the damper cuts off the admission of air and prevents the fire from getting a proper supply of air; opening the damper permits air to pass through the grates, and has the effect of promoting combustion.

New Power House Equipment

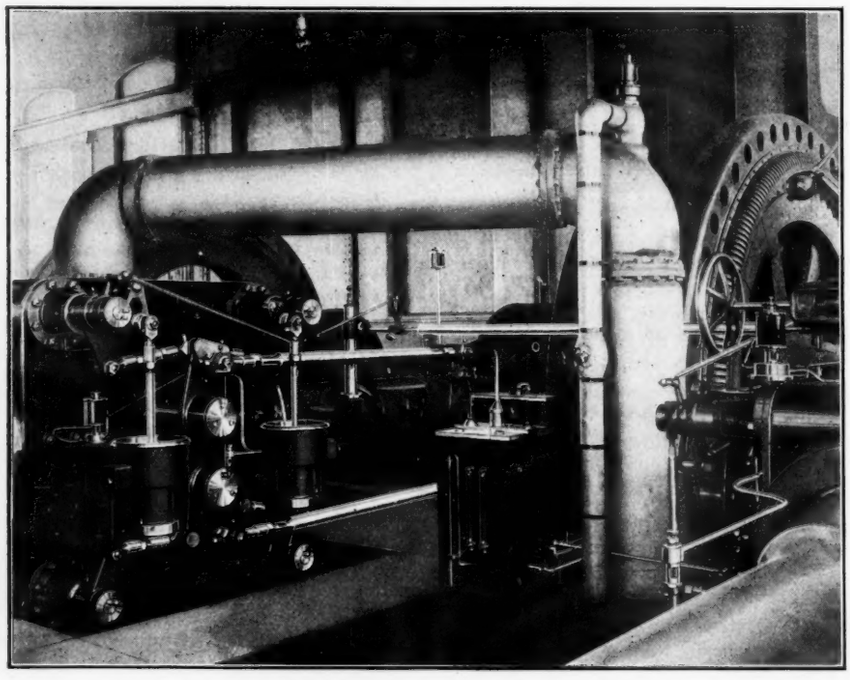
Richardson Automatic Oiling and Filtering System

What the inventor and the manufacturer are doing to save time and money in the engine room and power house. Engine room news.

The Richardson-Phenix Company, Milwaukee, Wis., is putting out a line of unit-oiling systems, which obviate the necessity of connecting two units to a common pipe line, or having any storage reservoirs or drainage tanks in the basement or overhead.

The filter is intended to be placed on the engine-room floor. A double-ended pump is attached to the filter and arranged to be driven from some part of the valve motion on the engine. A coupling is provided for the driving connection of this pump, which may be easily disconnected. A handle is provided so that the pump may be operated by hand when desired.

This pump handles the dirty oil at one end and clean oil at the other. One end of the pump is connected to a drainage-receiving well, to which all the drains from the engine are piped. This well is of cast iron, and is intended to be placed in or under the floor. It is provided with a substantial cap. A large, removable strainer catches the greater part of foreign matter draining away from the engine bed and bearings.



ARRANGEMENT OF FILTER AND OILING SYSTEM

The pump takes the dirty oil from the receiving well and forces it into the upper back chamber of the filter, where a heating coil is provided for warming the oil to assist in the separation of foreign matter and water. The overflow from this chamber is gradual, although the incoming oil may come in irregular quantities. This chamber is provided with a settling basin in the base for retaining such foreign matter as will settle at this point.

Flowing from this chamber, the oil enters a central separating chamber and passes down through a central tube, rising up through water, where the separation of dirt is carried on to a still further extent. This chamber is provided with a gage glass, so that the amount of water and oil may be observed. It is also provided with an automatic overflow so the amount of water will remain constant.

Overflowing through adjustable fittings, the oil from the upper chamber enters the filtering cylinders, which are wrapped with filtering cloths, the oil finally coming to rest in the main storage body of the filter, where a cooling coil may be provided if oil passing through the filter is large enough in quantity to demand it; or if the temperatures are such as to make it necessary to reduce the temperature of the oil.

The filtered oil is pumped up into a glass tank supported on a pipe stand, in which is an inner pipe serving as an overflow, carrying the oil down and out of the side opening in the base of the stand, the excess oil returning back to the pump.

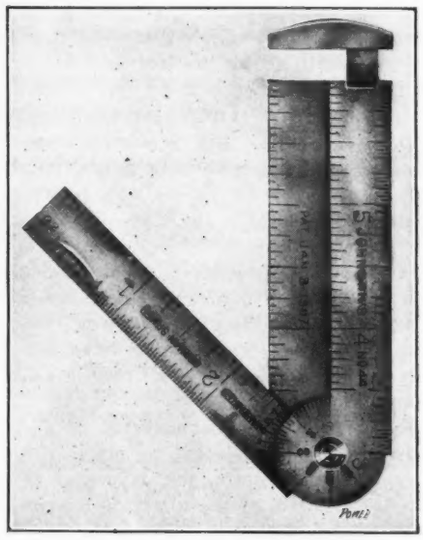
The glass tank on the overflow stand indicates the general operation of the system and offers a means of determining the efficiency of the action of the filter.

From the base of the overflow stand, a single pipe with its branches supplies the several sight feeds about the engine. A valve is provided in this line near the overflow stand, which may be closed when the engine is shut down. The opening and closing of this valve are all that is necessary in starting and stopping the entire system.

Johnson's Patent Combination Rule

This handy rule is 6 inches long, but doubles up on a center joint which is so constructed that the rule remains fixed wherever set.

The center joint is designed as a vernier, divided into ten parts, which correspond with nine divisions on the protractor scale. Each division on the protractor represents five degrees, so that each division on the vernier is smaller by one-half degree than the protractor spacing.



JOHNSON'S PATENT COMBINATION RULE

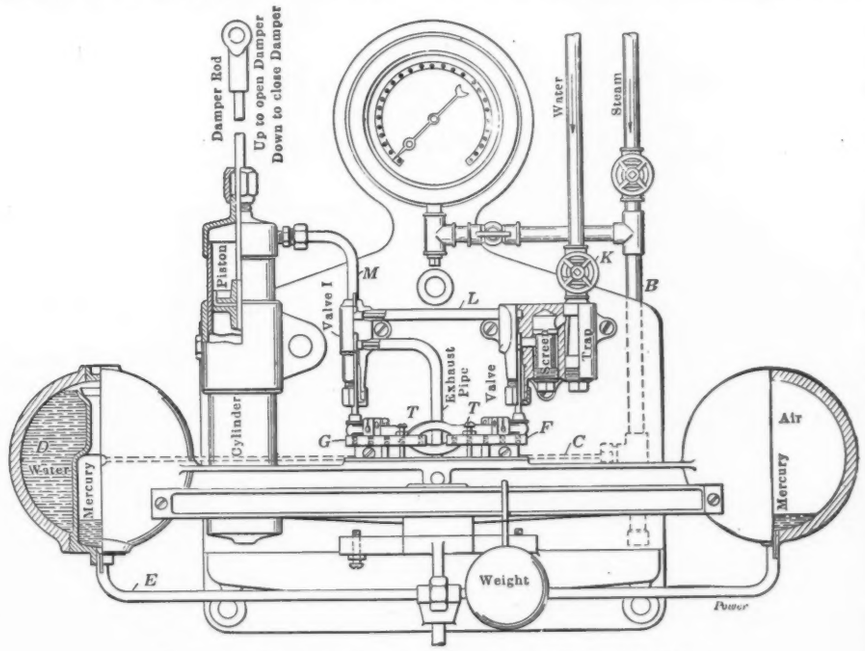
When determining the angle to which the rule is open, it is necessary to read

the protractor scale, count on the vernier the number of spaces up to the division line coinciding with one of the rulings on the protractor, and then add to the angle read off on the protractor the number of half degrees indicated by the vernier. Distinctive features of the rule may be readily seen upon examination.

The rule is made of german silver and is manufactured by the E. P. Johnson Rule Manufacturing Company, 553 Monroe street, Chicago, Ill.

The Diamond Furnace Regulator

The accompanying illustration shows the design of the Diamond damper regulator, which has been placed on the market by the Diamond Power Specialty Company, of Detroit, Mich. The novel feature in the construction of this machine is that of using mercury as a balancing power to control the inlet and outlet water valves.



SHOWING DETAILS OF DIAMOND FURNACE REGULATOR

This mercury is used in connection with two hollow globes which are supported by a connecting arm, which rests on a knife edge in the center. These hollow globes are also joined by a bypass, through which the mercury moves back and forth as the steam pressure increases or decreases. The movement of the mercury from one globe to the other brings an increase in weight on one side or the other of the knife edge, as the case may be, which causes the connecting arm to tip. The tipping of this arm opens or closes the water valves which control the damper.

Another feature is the simple method of regulating the steam-pressure point at which the damper may be closed, which provides for changes between day and night pressure of steam or for a change at any time desired. This is accomplished by simply sliding the weight on the bar to the right or left.

An important point in the construction is the ease of access to the water valves, which are so constructed that the stems may be reground into the valve seats without the removal of the stem from the valve body or the removal of any other parts of the regulator.

The regulator is connected to a water or air supply. This supply should have a pressure of at least 20 pounds. It is also connected with a steam line carrying boiler pressure.

The pipe *B* carries the steam to a flexible-drawn copper tube *C*, which connects with the globe *D*. This globe is filled with water due to condensed steam. As the globe fills, air is forced through the inner chamber and the bypass *E* and the mercury is driven before it into the hollow globe on the right. As the pressure in both of the globes becomes equalized, the mercury drops back into the bypass, where it remains to be shifted from one side to the other, according to the increase or decrease of the steam pressure. When the steam reaches the required pressure, the counterweight is placed on the scale in such position as to exactly balance the two hollow globes.

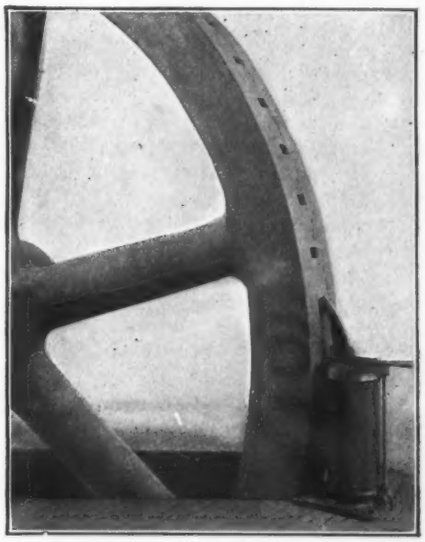
As the steam increases above the required pressure, the mercury is driven toward the hollow globe on the right, which increases the weight on that side and tips the arm. The tipping of the arm opens the inlet water valve by means of a lever connected at *F* with the valve stem and extending across the knife-edge rest and touching the balance arm by the use of an adjustable set screw *T*. The water, before reaching the inlet valve, passes through a trap or settling chamber and a screen. After passing the inlet valve the water flows through the pipes *L* and *M* to the cylinder, driving the piston down and closing the damper.

As the steam pressure decreases, the pressure in the globe *D* on the left also decreases and the compressed air in the hollow globe on the right assists in driving the mercury back to the left, causing the left end to become heavier. This movement of the mercury tips the arm down to the left side and closes the inlet valve which shuts off the water supply. At the same time it opens the outlet valve *I*, which allows the water to flow from the cylinder back through the pipe *M* into the exhaust pipe; the piston is drawn up by the weight of the damper as it opens.

The Badger Engine Jack

The Wisconsin Engine Company, Corliss, Wis., have designed a new type of engine jack which operates with either steam or compressed air and is designed to turn the flywheel quite rapidly, or ⅛ of an inch at a time, as desired.

The illustrations show the jack in position and the method of application. On large engines, and particularly engines getting hard service, where frequent inspection and quick adjustments are necessary, this jack is a saver of time and labor.



BADGER ENGINE JACK

If there is more than one engine and it is not desirable to equip each with a permanent jack, a base can be set in front of each wheel, and permanent piping laid from the source of steam or air supply to each base. An air or steam hose can be substituted for the permanent piping by connecting from a convenient plug in either the air or steam line.

This jack is built for any diameter or weight of wheel, and can be used for engines of all types and sizes, having square rim wheels with the ordinary barring holes.

NEW PUBLICATIONS

FUEL AND REFRACTORY MATERIALS. By A. Humboldt Sexton. Published by D. Van Nostrand Company, New York, 1910. Cloth; 360 pages, 5x7 inches; 104 illustrations; numerous tables. Price, $2.50.

This is the second edition of Professor Sexton's well known textbook, and the title page bears the legend: "New and revised edition"; the preface also informs the prospective reader that "the whole book has been carefully revised." It is unfortunate that the author used the adverb "carefully," in view of many of the statements and expressions found in the body of the book. A few of these are: "air which contains about 4 per cent. of CO_2, the oxygen being reduced by a like amount," on page 13; "the absolute zero for the Fahrenheit scale is —461 and that for the Centigrade scale —273," on page 32; the heat lost in flue gases "can be obtained by multiplying the products of combustion by their specific heats and the temperature at which they escape," on page 34; "39,600 B.t. units of heat," page 37; "the heat of combustion of benzene is found to be 1,418,310 B.t.u.," page 43; "the hydrogen in solid fuels is in the solid condition, and therefore heat must be absorbed in melting it," page 45; "the Priestman engine, which is the best known" oil engine, page 317; "1 B.t.u. = 772 foot-pounds," pages 311 and 352.

Besides the many blemishes of the kind just mentioned, there are careless inconsistencies and errors in copying or proof-reading; for example, on page 40 the heat value of carbon burned to CO = 4350, but on page 354 it has risen to 4370 B.t.u. On the latter page, the heat value of CO burned to CO_2 is given as 4370 instead of 10,130; on page 68, short flame fat coal is called "caking" coal when "coking" is meant.

The discussion of liquid fuels is perfunctory and skimpy, covering less than six pages, while forty-five are devoted to charcoal and coke. In discussing the heat value of fuels the author follows throughout the confusing and highly unpractical method of considering the atomic weights as pounds; a molecule of carbon being regarded as weighing 12 pounds, one of hydrogen two pounds, and so on.

In many places the tone is too dogmatic to be scientific; for example, in the statements on page 27 regarding dissociation. On page 15 the author puts forward the ancient and discarded argument (apparently in an effort to be scientifically precise) to the effect that when oxygen and hydrogen combine in what is termed "combustion," it is not necessarily the hydrogen that is burned —it may be the oxygen. And yet "the whole book has been carefully revised." Of what value is revision if it does not modernize and rectify?

The section on charcoal and coke and their production is far and away the best in the book All through, the purely descriptive parts are much superior to the analytical and scientific discussions.

OBITUARY

Joseph Garbett, for many years prominently identified with the mechanical industry of Minneapolis, died in his home in that city on Monday, August 22, of heart trouble, at the age of 58 years. He

JOSEPH GARBETT

had been in poor health for some time, but although of late unable to discharge his duties as chief engineer of the Minneapolis Steel and Machinery Company, he had seemed to be gradually mending, and had expected soon to resume his position in an advisory capacity at the works. A sudden change took place, however, and he passed away.

Mr. Garbett was born at Shropshire, England, in 1852. His early education was obtained under the greatest difficulties and only by exercising that high degree of determination which was characteristic of him and which led to his later success in life. He was a self-made man in every respect, having worked himself up from the lowest rounds of the ladder to positions of great responsibility in the mechanical world. The first years of his commercial life were spent in the Coalbrookdale Iron Works, England, finally becoming a superintendent in these works when about 23 years of age. In 1879, he left England, coming direct to Minneapolis and entering the employ of O. A. Pray & Co., a manufacturer of flour and sawmill machinery, as foreman patternmaker. He steadily developed into a thorough and able mechanic, and when the Twin City Iron Works was established, he and O. P. Briggs constituted the firm, Mr. Garbett serving as chief engineer. It was here that he designed the Twin City Corliss engine which is so favorably known throughout the country today.

When the Twin City Iron Works was absorbed by the Minneapolis Steel and Machinery Company, Mr. Garbett was prominent in its affairs, becoming mechanical engineer of that company and a director as well.

In addition to his other interests he was also senior partner in the firm of Garbett & Schneider, which does a large business in roll corrugating and kindred lines.

Mr. Garbett, although a forceful, able man of affairs, was of a retiring disposition and, though genial and always a true and loyal friend, he was chiefly devoted to his home, his business and his church. He was a mechanic of high standing and recognized ability, was a member of the American Society of Mechanical Engineers and an honorary member of Minneapolis No. 2, of the National Association of Stationary Engineers.

PERSONAL

Edward J. Kunze has been appointed assistant professor of mechanical engineering at the Michigan Argicultural College.

BOOKS RECEIVED

CHEMIST POCKET MANUAL. By Richard K. Meade. The Chemical Publishing Company, Easton, Penn. Leather, 443 pages, 4x6¾ inches, 39 illustrations, indexed. Price, $3.

HIGH-SPEED STEEL. By O. M. Becker. McGraw-Hill Book Company, 239 West Thirty-ninth street, New York. Cloth, 360 pages, 6¼x9⅜ inches, 273 illustrations, indexed. Price, $4.

NEW INVENTIONS

Printed copies of patents are furnished by the Patent Office at 5c. each. Address the Commissioner of Patents, Washington, D. C.

PRIME MOVERS

INTERNAL COMBUSTION ENGINE OF THE TWO-CYCLE TYPE. Alfred George Scholes, Ilford, England. 967,250.

TURBO-GENERATOR CONSTRUCTION. Charles H. Smoot, Chicago, Ill., assignor, by mesne assignments, to General Electric Company, a Corporation of New York. 967,254.

PNEUMATIC MOTOR. Eugene T. Turney, Rock Island, Ill., assignor to Artista Piano Player Company, Milan, Ill., a Corporation of Illinois. 967,271.

WIND-WHEEL ELECTRIC GENERATOR. Alfred Carlson, Klamath Falls, Oreg. 967,325.

WATER WHEEL. Thomas A. MacDonald, Clifton, N. J., assignor of sixteen and one-third one-hundredths to Isaiah E. Zimmerman, Paterson, N. J., sixteen and one-third one-hundredths to William H. Castles, Kingsland, N. J., and sixteen and one-third one-

hundredths to George Lentz, North Arlington, N. J. 967,402.

WAVE MOTOR. Arzeno W. Reynolds, Perris, Cal. 967,437.

TURBINE. Julius Brown, Peekskill, N. Y. 967,494.

STEAM TURBINE. Alexander Albert Holle, Olst, Netherlands. 967,639.

REVERSIBLE INTERNAL COMBUSTION ENGINE. Frederick T. Flinchbaugh, York, Penn. 967,749.

INTERNAL COMBUSTION MOTOR ENGINE TURBINE OR REACTION WHEEL. John Hutchings, London, England. 967,778.

COMPOUND INTERNAL COMBUSTION ENGINE. Robert M. Pierson, New York, N. Y., assignor, by mesne assignments, to C. P. Power Company, Newark, N. J., a Corporation of New Jersey. 967,828.

BOILERS, FURNACES AND GAS PRODUCERS

GAS GENERATOR. Nelson Goodyear, New York, N. Y., assignor to J. B. Colt Company, New York, N. Y., a Corporation of New Jersey. 967,183.

HYDROCARBON BURNER. Frederick R. Blount and Nelson Blount, New York, N. Y. 967,315.

ACETYLENE-GAS GENERATOR. John M. Flitcraft, Elkhart, Iowa, assignor of one-half to J. W. Fryer, Osceola, Iowa. 967,357.

AUTOMATIC FORCE - DRAFT SMOKE CONSUMER. James R. Harrell, Cincinnati, Ohio. 967,375.

SUCTION GAS PRODUCER. Constantine Lee Straub, Milwaukee, Wis., assignor to Loomis Pettibone Company, a Corporation of Connecticut. 967,459.

VAPOR BURNER. Harry V. Dresbach and Warren R. Morey, Iola, Kan. 967,622.

OIL BURNER. George Franklin Moody, Altoona, Penn. 967,653.

WATER - TUBE STEAM GENERATOR. August Gottlob Burkhardt, Düsseldorf, Germany. 967,718.

STEAM BOILER. Edward P. Hanahan, Springfield, Ohio. 967,763.

POWER PLANT AUXILIARIES AND APPLIANCES

INJECTOR. Robert Grundy Brooke, Macclesfield, England. 967,717.

THREE-WAY VALVE. Constantine Lee Straub, Perth Amboy, N. J., assignor to Marine Producer Gas Power Company, a Corporation of New York. 967,460.

ROTARY STEAM VALVE. Scott W. Perry, Versailles, Ill. 967,827.

AUTOMATIC AIR PUMP. James A. Kenworthy, Oakland, Cal. 967,199.

GAS CLEANER. Leon P. Lowe, San Francisco, Cal. 967,212.

WATER-LEVEL CONTROLLER. Edward P. Noyes, Winchester, Mass., assignor to C. P. Power Company, Newark, N. J., a Corporation of New Jersey. 967,228.

PACKING. Hakon Wilfred Ramberg, Brooklyn, N. Y. 967,235.

VALVE REGULATOR IN CORLISS ENGINES. Soffus Strommerson, Sioux City, Iowa, assignor of one-half to Edgas Beaumont, Sioux City, Iowa. 967,261.

BALANCED STEAM FITTING OR JOINT FOR JOURNALS OF ROTARY STEAM CYLINDERS. Alonzo Aldrich, Beloit, Wis. 967,294.

BELTING. John W. Hilton, Bellevue, Ky. 967,379.

PACKING. John C. Kingsbury, Dudley, Mass. 967,392.

CARBURETER FOR EXPLOSIVE ENGINES. Godfried J. Mayer, Buffalo, N. Y., assignor of five-twentieths to Donald R. Clark and four-twentieths to Herman Mayer, Buffalo, N. Y. 967,407.

CONTROLLING MEANS FOR TURBINES. Henning G. Sahlin, Malden, Mass., assignor of forty-five one-hundredths to David Rice, Boston, Mass. 967,444.

UNION CHECK VALVE. Harry H. Groh, Monocacy, Penn., assignor of one-half to James R. Kline, Monocacy, Penn. 967,514.

VALVE-RESEATING DEVICE. Andrew M. Lockett, New Orleans, La. 967,532.

WATER-COOLED PISTON FOR GAS ENGINES. Gustav B. Petsche, Philadelphia, Penn., assignor to Southwark Foundry and Machine Company, Philadelphia, Penn., a Corporation of Pennsylvania. 967,551.

STARTING AND REVERSING MECHANISM FOR GAS ENGINES. John V. Rice, Jr., Bordentown, N. J., assignor to Rice Gas Engine Company, Bordentown, N. J., a Corporation of New Jersey. 967,559.

FURNACE-DOOR OPENER. William J. Rohan, Racine, Wis. 967,565.

PIPE JOINT. Wesley Christy, Globe, Ariz. 967,611.

WATER GAGE. George H. Goodwin, Los Angeles, Cal. 967,634.

VALVE. Cassius Clay Palmer, New York, N. Y., assignor, by mesne assignments, to the Railway and Stationary Refrigerating Company, New York, N. Y., a Corporation of Maine. 967,659.

HOSE COUPLING. William H. Shepheard, Portsmouth, Va. 967,679.

MOTOR FOR DRIVING BOILER-TUBE CLEANERS. Henry F. Weinland, Springfield, Ohio, assignor to the Lagonda Manufacturing Company, Springfield, Ohio, a Corporation of Ohio. 967,693.

VALVE MECHANISM. Edward V. Anderson, Monessen, Penn., assignor of one-half to Charles E. Golden, Crafton, Penn. 967,702.

STEAM-ENGINE AIR PUMP. Thomas Thompson, Blackheath, England. 967,860.

ELECTRICAL INVENTIONS AND APPLICATIONS

ELECTRIC-WELDING APPARATUS. Alvin E. Buchenberg, Toledo, Ohio, assignor, by mesne assignments, to the Toledo Electric Welder Company, Cincinnati, Ohio, a Corporation of Ohio. 966,382.

TIME SWITCH. Willeston C. Pugh, Seattle, Wash., assignor of one-half to August Gamblee, Seattle, Wash. 966,118.

INDUCTION LAMP. Peter Cooper Hewitt, New York, N. Y., assignor to Cooper Hewitt Electric Company, New York, N. Y., a Corporation of New York. 966,204.

ELECTRIC DRILL. Frederick W. King, Cleveland, Ohio. 966,217.

DYNAMO ELECTRIC MACHINE FOR THE PRODUCTION OF CONTINUOUS AND ALTERNATING CURRENTS. Jakob Schurch, Bruchsal, Germany. 966,246.

ELECTRIC SWITCH. John F. Smiley, Louisville, Ky. 966,252.

CIRCUIT BREAKER. William E. Richards, Portage, Penn. 966,360.

TEST COUPLING FOR ELECTRIC CONDUCTORS. Patrick J. McDonald, Rochester, N. Y., assignor of one-half to George H. Smith, Rochester, N. Y. 966,400.

INDICATOR FOR ARC LAMPS. Joseph H. Allen, Chicago, Ill., assignor, by mesne assignments, to General Electric Company, a Corporation of New York. 967,151.

LOW - SPEED CIRCUIT CONTROLLER. Fred B. Corey, Schenectady, N. Y., assignor to General Electric Company, a Corporation of New York. 967,171.

ALTERNATING-CURRENT MOTOR. Valere Alfred Fynn, London, England. 967,362.

INSULATION BAG FOR CONDUITS. Anton Funke, Westig, Germany, assignor to the Papyrus Artificial Paper Manufacturing Company, Hoboken, N. J. 967,360.

METHOD OF ELECTRIC WELDING AND REPAIRING. Heinrich L. J. Siemund, New York. 967,579.

ELECTRIC TERMINAL. Eduard Gerhardt, Jr., Mauer, near Vienna, Austria-Hungary. 967,631.

ARC LAMP. Charles H. Sprague, Newton, Mass., assignor to Starbuck Sprague, Boston, Mass. 967,684.

ELECTRIC ARC LAMP. Thomas Joseph Digby, London, England. 967,738.

MOTOR - CONTROLLING APPARATUS. Samuel H. Keefer, Plainfield, N. J., assignor to Niles-Bement-Pond Company, Jersey City, N. J., a Corporation of New Jersey. 967,782.

POWER PLANT TOOLS

PIPE WRENCH. Peter E. Erickson, Port Chester, N. Y. 966,182.

PIPE WRENCH. William T. Bennett, Mason City, Ill. 966,300.

LIFTING JACK. Alfonzo F. Wilson, Worthington, Ind. 966,374.

EXPANSION BOLT. James H. Baker, Springfield, Ill. 966,515.

RATCHET DRILL. Joseph M. Reams, New York, N. Y. 966,597.

WRENCH. Homer J. Munday, Carterville, Mo. 966,698.

WRENCH. Adolphus C. Clements, Villanow, Ga. 966,888.

WRENCH. Hugh McDonald, New Castle, Penn. 966,943.

ELECTRICAL-ALARM SYSTEM. Albert Goldstein, New York, N. Y., assignor to International Electric Protection Company, a Corporation of New York. 966,903.

WRENCH. Dwight Moody Russell, Bulger, Penn. 967,062.

LIFTING JACK. Charles E. Hulander, Pittsburg, Penn., assignor to the Duff Manufacturing Company, Pittsburg, Penn., a Corporation of Pennsylvania. 967,126.

ENGINEERING SOCIETIES

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Pres., George Westinghouse; sec., Calvin W. Rice, Engineering Societies building, 29 West 39th St., New York. Monthly meetings in New York City.

NATIONAL ELECTRIC LIGHT ASSOCIATION

Pres., W. W. Freeman, Brooklyn, N. Y.; sec., T. C. Martin, 31 West Thirty-ninth St., New York.

AMERICAN SOCIETY OF NAVAL ENGINEERS

Pres., Engineer-in-Chief Hutch I. Cone, U .S. N.; sec. and treas., Lieutenant Henry C. Dinger, U. S. N., Bureau of Steam Engineering, Navy Department, Washington, D. C.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION

Pres., E. D. Meier, 11 Broadway, New York; sec., J. D. Farasey, cor. 37th St. and Erie Railroad, Cleveland, O. Next annual meeting at Chicago, Oct. 10-13, 1910.

WESTERN SOCIETY OF ENGINEERS

Pres., J. W. Alvord; sec., J. H. Warder, 1735 Monadnock Block, Chicago, Ill.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA

Pres., E. K. Morse; sec., E. K. Hiles, Oliver building, Pittsburg, Penn. Meetings 1st and 3d Tuesdays.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Pres., Dugald C. Jackson; sec., Ralph W. Pope, 33 W. Thirty-ninth St., New York. Meetings monthly.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.

Pres., Prof. J. D. Hoffman; sec., William M. Mackay, P. O. Box 1818, New York City.

NATIONAL ASSOCIATION OF STATIONARY ENGINEERS

Pres., William J. Reynolds, Hoboken, N. J.; sec., F. W. Raven, 325 Dearborn street, Chicago, Ill. Next convention, Rochester, N. Y., September 12-17, 1910.

UNIVERSAL CRAFTSMEN COUNCIL OF ENGINEERS

Grand Worthy Chief, John Cope; sec., J. U. Bunce, Hotel Statler, Buffalo, N. Y. Next annual meeting in Philadelphia, Penn., week commencing Monday, August 7, 1911.

AMERICAN ORDER OF STEAM ENGINEERS

Supr. Chief Engr., Frederick Markoe, Philadelphia, Pa.; Supr. Cor. Engr., William S. Wetzler, 753 N. Forty-fourth St., Philadelphia, Pa. Next meeting at Philadelphia, June, 1911.

NATIONAL MARINE ENGINEERS BENEFICIAL ASSOCIATIONS.

Pres., William F. Yates, New York, N. Y.; sec., George A. Grubb, 1040 Dakin street, Chicago, Ill. Next meeting, St. Louis, Mo., January 16-21, 1911.

OHIO SOCIETY OF MECHANICAL ELECTRICAL AND STEAM ENGINEERS

Pres., O. F. Rabbe; sec. and treas., Prof. F. E. Sanborn, Ohio State University, Columbus, Ohio.

INTERNATIONAL MASTER BOILER MAKERS' ASSOCIATION

Pres., A. N. Lucas; sec., Harry D. Vaught, 95 Liberty street, New York. Next meeting at Omaha, Neb., May, 1911.

INTERNATIONAL UNION OF STEAM ENGINEERS

Pres., Matt. Comerford; sec., Robert A. McKee 606 Main St., Peoria, Ill. Next convention, Denver, Colo., September, 1910.

NATIONAL DISTRICT HEATING ASSOCIATION.

Pres., G. W. Wright, Baltimore, Md.; sec. and treas., D. L. Gaskill, Greenville, O.

Preparing Boiler for Inspection

The inspection of a steam boiler is a matter of vital importance. When notified to prepare a boiler for internal inspection, proceed to cool down and clean the boiler. Remove all scale, clean out the ashes and soot on the grates and in the combustion chambers, and sweep off the plates, heads and tubes, so that every part of the boiler may be examined and its exact condition determined. Have the boiler cold for the inspector when he arrives. Have the steam gage ready for testing, water-column connections open for inspection, and everything in readiness to facilitate a thoroughgoing inspection of the boiler and all its connections. —The Fidelity and Casualty Company of New York.

BUSINESS ITEMS

The Vilter Manufacturing Company, Milwaukee, Wis., has recently received contracts for six refrigerating plants from 23 to 80 tons; also orders for five Corliss engines, three of which will be used for driving refrigerating machines.

The Syracuse Industrial Gas Company, Vernon, New York, is to install shortly a 35-kilowatt complete gas-power lighting outfit for the Cycle Hatcher Company, Elmira, N. Y. This will be a suction producer and generator direct connected to gas engine. This is a repeat order.

The Magnolia Metal Company, 112 Bank street, New York, is in receipt of a letter from H. C. Martell, of Balboa, Canal Zone, Panama, in which he says: "I suppose there is more Magnolia metal being used on the machinery bearings on this 'big ditch' than on any other large job in the world, and it is without doubt giving all us engineers entire satisfaction."

The Wheeler Condenser and Engineering Company, of Carteret, N. J., builders of Wheeler dry-tube condensers, Wheeler rectangular jet condensers, Wheeler admiralty type condensers, Wheeler-Edwards air pumps, etc., has recently acquired the drawings and patterns of the Conover condenser and are prepared to furnish condensers of this type and repair parts for those now in use.

The Ohio Brass Company, of Mansfield, Ohio, will occupy booth No. 80, with its exhibit at the Rochester convention, and will show a complete set of samples of its entire line, especially featuring its regulating valve, gage cocks, water gage, etc., with section samples. The company will be represented by W. T. Jameson, general sales agent and C. N. Allerding, of the engineering department.

The Sterling Lubricator Company, of Rochester, N. Y., is erecting a new factory for the manufacture of its Sterling force-feed lubricators. The new plant is expected to be in operation by the first of the new year. The demand for Sterling lubricators has increased to such a large number that the company has found it necessary to triple its output, and the new factory has been designed with this end in view.

Bulletin 1051, on "Revolving Field Alternators," recently issued by the Ideal Electric and Manufacturing Company, of Mansfield, Ohio, not only gives the details of construction of a new line of alternators which they have recently perfected, but also gives test curves and data showing the performance of these machines under various conditions. It also contains discussion and curves showing the influence of power factor on efficiency, heating characteritics, exciting current and power necessary to drive the machine. These generators are of the revolving-field type and are built in sizes up to 250 k.v.a. and in all standard voltages. The bulletin contains numerous illustrations and will be sent to interested persons upon request. This is the first of a series of engineering pamphlets to be published and the Ideal Electric and Manufacturing Company will be pleased to place the names of engineers who are interested upon their mailing list.

In a 96-page book entitled, "High Efficiency of Centrifugal Pumps," the De Laval Steam Turbine Comapany, of Trenton, N. J., has brought together some 75 charts, diagrams, photographs and a vast amount of engineering information relating to such subjects, as ways and means for testing centrifugal pumps, charts of the results of such tests, the interpretation of these charts for the purposes of the engineers, etc. Valuable suggestions are given for the drawing up of specifications and for testing pumps, to ascertain whether or not specifications have been made. In this connection it is stated that the De Laval Steam Turbine Company guarantees beforehand the characteristics of the pumps built by it and subjects each pump to a thorough test at the works. The purchaser is invited to witness this test and a full report is supplied to him. This book will undoubtedly prove of interest to anyone having to do with pumping machinery in any way.

A new firm of belting manufacturers has been organized, known as the Olmsted-Flint Company. This firm will maintain its principal offices at 136 Liberty street, New York City, and a branch house at 1026 Arch street, Philadelphia. It is also announced that branch houses will also be established in the near future in Chicago and Boston. The incorporators of the new company are: Willard I. Olmsted, Stanley B. Flint and George S. Baker. The Olmsted-Flint Company will manufacture a complete line of leather belting, balata belting, canvas stitched belting, rubber belting and solid woven belting. It has taken over a large plant in Philadelphia for the manufacture of its leather belting. The firm will also represent exclusively in the United States several large European manufacturers of belting and transmission specialties. The members of the new concern are well known in the belting field, having been connected for some years past with one of the largest of the belt manufacturers. One of the features of the new organization will be the establishment of an engineering and experimental department, which will make a study of belt conditions and methods of reducing costs in both the transmission and conveying field. F. M. Schiffmacher, a well known transmission engineer, will head this department.

NEW EQUIPMENT

Prince Albert, Sask., will install a new filtration plant.

Winnipeg, Man., will expend $60,000 on a new gas plant.

Souris, Man., will install a complete new waterworks system.

The town of Walworth, Wis., voted to issue $18,000 bonds for waterworks.

The town of Rainy River, Ont., will build a large new pumping station.

The Harvey Shoe Company, Gardner, Me., will install a new water wheel.

The city of Higginsville, Mo., contemplates enlarging its electric-light plant.

The Spring Lake (N. J.) Water Works will build a new pumping station.

The Pipper Light and Power Company will equip a plant at Montreal, Canada.

A new ice plant will be erected by the Pottstown (Penn.) Brewing Company.

The Ottawa (Ont.) Light, Heat and Power Company will equip a large new substation.

New Glasgow, N. S., will spend $25,000 in equipping a complete new waterworks system.

The Peoples Coal Company, Taunton, Mass., is taking prices on hoisting engines and boilers.

C. E. Giddings, Hudson, Mass., is in the market for a 12- to 15-horsepower gasolene engine.

Peterboro, Ont., is calling for tenders for electrically operated air compressors and ejectors.

E. H. Lundy has asked the council at Eldora, Ia., for a franchise to install an electric-light plant.

The people of Osyka, Miss., voted to issue $20,000 bonds for waterworks and electric-light plant.

The town of Akron, Iowa, is advertising for bids on the installation of an electric-lighting plant.

The citizens of Bellefourche, S. D., voted to issue $50,000 bonds for the construction of waterworks.

The Central Georgia Packing and Provision Company, Macon, Ga., will erect an ice and cold-storage plant.

Daniels & Fisher, Denver, Colo., are building a large addition and expect to install some new power equipment.

The South Shore Traction Company has purchased site for a power plant on Oakwood avenue, Bayport, L. I.

The city of Terrell, Tex., voted to issue $10,000 bonds for improving its electric-light plant and waterworks.

The citizens of Cambridge City, Ind., voted to issue $8000 bonds for improving its water and electric-light plant.

The Narragansett Electric Lighting Company, Providence, R. I., will install a new steam turbine and generator.

The city of Fairview, Okla., will extend its electric-light system, install power equipment, etc. J. N. Voorhees, city clerk.

The city of Shelbina, Mo., contemplates installing a boiler in its electric-light plant. E. P. Weaver is superintendent.

W. W. Womack, Jackson, Miss., contemplates developing water power to generate electricity for lighting and power.

The Peoples Railway, with headquarters at Stratford, Ont., will be in the market for large quantities of electrical equipment.

The city of Boston, L. R. Rourke, superintendent of streets, is requesting bids for two steam turbine driven centrifugal pumps.

The citizens of Albertville, Ala., voted to issue $25,000 bonds for waterworks. J. B. McCravy Company, Atlanta, Ga., engineers.

The Hocking Valley Creamery Company, Athens, Ohio, recently organized, will erect a plant for a general creamery and ice-cream business.

The Suburban Gas Company will erect a plant at Houston Heights, Tex. The company was recently incorporated and granted a franchise.

The city of Thibodaux, La., will open bids September 23, for the construction and installation of an electric-light plant. R. J. Maquin, clerk.

The East Liverpool (Ohio) Traction and Light Company has purchased a building at Yellow Creek, which will be remodeled and equipped as a pewer station.